The Inherent Limitations of Spacepower: Fact or Fiction?

by

Major Gregory Billman

INTRODUCTION

> *Control of space means control of the world, far more certainly, far more totally than any control that has been achieved by weapons or troops of occupation. Space is the ultimate position, the position of total control over Earth.*
>
> —Lyndon Baines Johnson

> *Now the competition will be for the possession of the unhampered right to traverse and control the most vast, the most important, and the farthest reaching element on the earth, the air, the atmosphere that surrounds us all, that we breathe, live by, and which permeates everything. . . . A new set of rules for the conduct of war will have to be devised and a whole new set of ideas of strategy learned by those charged with the conduct of war.*
>
> —Brigadier General William "Billy" Mitchell[1]

Is American spacepower's current subordinate position to terrestrial military powers—air, land, and sea—due to inherent limitations? Spacepower today is limited in its ability to accomplish many military missions. Whether those limitations are predominantly inherent to the space environment or are self-imposed by the current US approach to space is the subject of this study.

Following a clear definition of spacepower, three steps are taken in the analysis process. First, the relative importance of spacepower as it is generally regarded is discussed in relation to the other forms of military power. Historical analogy with the accession of airpower from the early twentieth century onward seems particularly appropriate. Terrestrial military theory and space theory are subsequently discussed from a historical context, leading to a discussion of

18 SEPTEMBER 97

POC: SCHOOL OF ADVANCED AEROSPACE STUDIES
AIR UNIVERSITY
MAXWELL AFB AL 36112

current space doctrine, as it relates to spacepower's current supporting military role. In the application of theory and doctrine, current technologies are considered as they demonstrate space capabilities beyond those presently fielded. Second, the physical attributes of space are examined to establish whether the medium has inherent physical limitations. Third, beyond physical limitations, the issue of inherent limitations due to a lack of military utility is addressed. Military power characteristics are discussed as they apply to (1) terrestrial power, (2) currently fielded space forces, and (3) space forces which are technologically feasible. The characteristics include strategic agility, ability to demonstrate commitment and credibility, and economic, military and political considerations.

Conclusions and implications are discussed as they apply to the future potential of American spacepower. Depending on the findings, doctrinal implications exist to properly use spacepower—either as an adjunct force with terrestrial power, or as an independent military force.

Spacepower Defined

No standard definitions seem to exist for air, land or sea power. However, all seem to have similar characteristics, and hence spacepower can be defined in a similar manner. As Lt Col David E. Lupton writes in his work *On Space Warfare: A Spacepower Doctrine:*

> Spacepower is the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation.[2]

The United States is a spacepower dependent nation. It has a space infrastructure, both civilian and military, and is presently exploiting space for many purposes. As naval forces supply the military component of sea power, and air forces provide the military component of airpower, so

too do space forces supply the military component of spacepower. Given this definition, what follows is an examination of how spacepower has developed as compared to other military powers, specifically airpower, and how this development has affected current spacepower doctrine.

MILITARY POWER DEVELOPMENT AND SPACEPOWER S RELATIVE IMPORTANCE

The air war of yesterday becomes the space war of tomorrow.

—1960 Democratic Party Policy Statement

Spacepower is evolving into a mature military entity—much like airpower evolved into a dominating military force. This section reviews spacepower's development and its relationship to airpower's historical development to demonstrate that spacepower, like airpower, owes its potential rapid rise as a dominating form of warfare to its unique ability to affect adversaries in ways previously unimaginable.

Many similarities exist between airpower's development and spacepower, some are cursory, while others are more concrete. Cursory similarities include the difficult conceptual thought required in both cases to develop theories exploiting the military potential of fundamentally new and environmentally hostile mediums, the requirement for a technological knowledge base of current and future developments, and the need for a doctrinal push by military organizations to claim the developmental turf of a new medium. More concrete similarities to be discussed here include the way in which each power's resources were first employed, the evolution and relationship of each power's technologies to new roles, and the organizational development of each power within the military.

Early Employment of Airpower and Spacepower

Peter Hays states "the first military use of these two new mediums was for observation and reconnaissance."[3] In actuality, in 1911-12, prior to World War I, the Italians used airpower

in all four present-day mission areas against the Turks in Libya (force application, force enhancement, control and support). Lee Kennett, in his book *The First Air War, 1914 -1918,* suggests that it was this experience that caused a young Italian artillery officer, named Giulio Douhet, to remark, "A new weapon has come forth, the sky has become a new battlefield." Though Hays' remark is not completely accurate, his concept is predominantly regarded as valid. Force application did play a considerable, if not a major role in WW I airpower. Lighter-than-air German dirigibles were used early on in both reconnaissance and bombing roles.[4] Additionally, the rudiments of counterair weapons began development in the early years, but it wasn't until the latter part of the war that purpose-built anti-aircraft weapons appeared on the battlefields. It is generally accepted that the overwhelming bulk of sorties flown by any side in World War I involved aircraft and airships in tactical observation and reconnaissance roles. Likewise, Operation Desert Storm, fought seventy-seven years later, utilized military space assets in much the same way. Desert Storm has been called "The First Space War," harking to World War I's appellation, "The First Air War."[5] [6]

The Great War gave airpower its first large scale opportunity to contribute, mostly by observing for artillery placement and reconnaissance of enemy troop movements and dispositions. In his book *The First Air War: 1914–1918,* Kennett emphasizes this point. He illustrates airpower's contributions and technical development from both sides, including German airpower's value at the Battle of Tannenberg and Allied airpower's efforts at the Battle of the Marne. He discusses specifically how airpower supported earth-bound forces via communications, positioning, and intelligence and surveillance.

In the early stages of the Great War, as the Germans moved swiftly across the European continent, German observation planes were found most compatible with this rapid movement.

From August 15 until September 9, 1914, the *Fliegerabteilung* of the German Third Army Corps changed airfields eighteen times and during that time was grounded by bad weather only two days.[7] Aircraft became essential to command and control of German forces. Commanders now had much better information to determine where enemy armies were and, consequently, were better prepared to move their troops. Kennett writes: "German observation planes played a significant role in the east, where their reports, coupled with interceptions of Russian radio transmissions, set the stage for the victory at Tannenberg. Field Marshal von Hindenburg acknowledged his debt to the German Air Service: 'Without the airmen no Tannenberg.'"[8]

Positioning of friendly (for navigation and tactical purposes) and enemy forces (for targeting purposes) became exceedingly more precise with the advent of the balloon, and then the airplane. Not only did aircrews directly report positions of friendly and enemy troops, but balloons, which were in use for observation purposes, were used by fixed-wing aviators and ground troops to determine their position relative to friendly lines.

Though, as previously discussed, airpower played other significant roles in the Great War, intelligence and surveillance were generally regarded as its *raison d être.* Altitude, and the capability to travel well behind enemy lines, gave airmen the unique capability to see and determine things never before available to opposing forces. Information on force movements, troop dispositions, deployed weaponry, and enemy re-supply capabilities all became available to the commander who was lucky enough to be supported by air machines. In short, the visibility restricted by the "fog of war" became a bit clearer with the introduction of airpower.

There are strong analogies to be made between the emergence of airpower in World War I and the emergence of spacepower in Operation Desert Storm. While it is true that spacepower in the Gulf did not contribute to all four mission areas as airpower did in the Great War, as with

airpower in World War I, the Gulf War provided spacepower with its first large scale opportunity to demonstrate its capabilities. Similarly, these capabilities were generally limited to force enhancement, reconnaissance and other command and control-enhancing operations. Spacepower severely reduced the "fog and friction of war" for supported commanders, while it increased the opportunity for "fog" to cloud the enemy's decision making and "friction" to increase the enemy commander's difficulties. As the Great War proved the efficacy of airpower as a valuable tool for future conflict, the Gulf War seems to have proved the efficacy of spacepower as a viable arm of future military operations. Similar to the dominant role of airpower in World War I, Allied space assets in the Gulf were limited to functions which supported the other military arms. In today's terms, spacepower's main focus in the Gulf was direct support to the warfighter, or force enhancement

Force enhancement includes spacepower capabilities that "provide effective operational support to military forces."[9] As airpower multiplied the combat effectiveness of surface-bound forces in World War I, so too did spacepower multiply the combat effectiveness of terrestrial weapon systems in the Gulf. In fact, a comparison of each powers' early functions demonstrates the similarities. Specifically, in the Gulf, force enhancement capabilities included *communications, navigation, positioning, intelligence and surveillance (including weather).*

Communications in Desert Shield / Desert Storm was accomplished via the Defense Satellite Communications System (DSCS) and Fleetsat fleets of spacecraft. The system provided a high data rate, high capacity, worldwide, secure voice communications system for command and control, crises management, and intelligence data transmission between the field units, theater command structure and the National Command Authority (NCA). As well as supplying direct communications links, DSCS also provided a bridge for terrestrial communications systems with

line-of-sight restrictions across the vast expanses of desert. DSCS provided real time communications between land, air and sea units, as well as television into and out of theater. As the military communication systems became saturated, a "Civil Reserve Space Fleet" concept (analogous to the Civil Reserve Air Fleet or CRAF concept) was adopted to use commercial communications satellites to relay non-secure and non-priority traffic.

Navigation and positioning efforts in the Gulf were carried out by the NAVSTAR Global Positioning System (GPS) fleet of satellites. This system provided Coalition forces precise three-dimensional location and time information. The featureless desert terrain posed significant navigational challenges, thereby increasing the benefit of GPS. Additionally, many targeting systems on US weapons systems (of all services) interfaced with GPS for highly accurate initial, mid-course and terminal guidance. Its popularity became so widespread that aircrews flying Vietnam-era systems, which used notoriously untrustworthy analog inertial navigation systems, bought personal, hand-held GPS receivers to augment their on-board systems.[10] Parents of some infantry personnel included GPS receivers in their children's "CARE" packages. At the outbreak of Desert Shield, the NAVSTAR system had not yet reached full operational capability, but it soon became integral to the Coalition effort. In the future, planners believe small, lightweight GPS receivers will become standard kit for every deployed US soldier.

Surveillance in the Gulf was accomplished by the US fleet of spy satellites whose name(s), configuration(s) and specific characteristic(s) is/are classified. Civil and commercial satellites, such as the French SPOT, used for earth observation, were pressed into service to provide additional surveillance for the Coalition. A widely publicized, key capability of US surveillance satellites is multi-spectral sensing. Satellites over the Gulf provided US commanders and decision makers with optical, radar, and infrared (IR) high resolution images. Other capabilities included

electronics intelligence gathering, or ELINT, though this capability was not as valuable once the war began since Iraqi command and control capability was rapidly degraded early in the conflict. High quality and rapid Battle Damage Assessment (BDA) was another significant advance credited to space systems. Unit complaints about untimely BDA can be attributed to human errors in developing an inefficient and ineffective dissemination system vice technical inadequacies in space systems, though certain space force over classification problems did also, and still do, exist. The highly accurate photo and radar images provided by space platforms allowed for intricate interpretation of damage caused by Coalition "smart bombs."

Surveillance assets were also used to assist in targeting Iraqi SCUD missile launches. The Defense Support Program (DSP) fleet of spacecraft provided this capability. These satellites sat in their geostationary orbits, constantly looking for tell-tale SCUD IR plumes. Once observed, the system relayed the location, time and trajectory to USSPACECOM operations crews, who then evaluated and assessed the data before relaying, via the DSCS, to Patriot missile crews in Saudi Arabia, Israel or Turkey. USSPACECOM relay procedures had been practiced for years in accordance with Cold War plans, however the short time factor involved in SCUD launches (roughly seven minutes from launch to impact) forced USSPACECOM to modify relay procedures. New warning alert communications paths were established, refined and exercised. Though United States Central Command (USCENTCOM) had ballistic missile warning information available in early August, the procedures developed between USSPACECOM and USCENTCOM crews during Desert Shield probably paid off in saved lives and resources during Desert Storm.

Evolution and Relationship of Airpower and Spacepower Technologies to New Roles

Simultaneous with the evolution of airpower's operational role was an evolution of air-related technology. Similarly, the evolution of space-related technology has accompanied the evolution of spacepower's operational role.

As airpower developed rapidly from a technological standpoint, so too did its military potential. Within the span of just a few years, the dominant role of airpower evolved from general support to directly offensive. Spacepower is now advancing technologically in a very rapid manner. There seems no reason to assume that spacepower cannot, technologically, mimic airpower's offensive evolution. The most powerful early doctrines developed for both airpower and spacepower emphasized the war-winning potential of strategic applications of force from these new combat mediums.[11] As spacepower doctrine evolves, the strategic usefulness of applying force from this medium must be acknowledged, while taking care not to fall into early airpower's doctrinal trap of promising too much, too soon.

As airpower advanced technologically after World War I, its primary function became strategic bombardment. Giulio Douhet, impressed by airpower's capabilities and potential that he witnessed in the Great War, drafted an offensive airpower theory in *The Command of the Air.* Other great airpower thinkers followed, General William "Billy" Mitchell, Alexander de Seversky, Air Vice Marshal Hugh Trenchard, and General James "Jimmy" Doolittle, to name a few. All focused on the offensive capabilities of airpower. The lesson which flowed from these air-advocates was clear: an air force's sole concern should be to do the enemy the greatest possible amount of surface damage in the shortest possible time[12] [in consonance with the Theater Campaign Plan].

By the end of World War I, technology allowed airpower to be used, separate from surface forces, to bomb well beyond the battle front in efforts to affect the enemy infrastructure and its ability to wage war—as part of the overall Theater Campaign Plan. Government centers, industry, and transportation links were targetable by air though such targets were not at great risk due to the limits of the technology. This changed over time. An analogy to this situation can be drawn with the evolutionary advance of spacepower today. Technologically, spacepower clearly has access to the battlefield, yet it is limited in what it can do offensively. This, too, may change over time. And when it does, the political and military advantages of being able to rapidly and widely affect an enemy with minimal regard to friendly vulnerabilities will be great.

Organizational Development of Airpower and Spacepower within the Military

Part and parcel to the operational and technological development of airpower was its organizational development. Many writers advance the idea that it was actually the wish to identify a need for independent air forces that spawned offensive airpower theories. Due to airpower's evolution during the interwar years, incremental organizational changes took place. In the US, the changes led from an Air Service to an Air Corps to an Army Air Force, and finally to an independent Air Force. The emergence of Air Force Space Command (AFSPACECOM) and USSPACECOM may be similar organizational steps towards the eventual creation of an independent Space Force.[13]

Douhet, Mitchell and other airpower thinkers pushed for establishment of separate air forces due to their perceptions that airpower proved a decisive form of warfare. Strategic bombardment became the backbone of the air mission. This legacy is apparent in Air Force Manual 1-1, as it contrasts surface forces to "aerospace power" which "can be the decisive force

in warfare."[14] It seems with all of the attention paid to strategic attack as the *raison d être* of the USAF, the removal of this mission might signal a certain lack of legitimacy in the institution. Without a strategic attack capability, the Air Force would be nothing more than a support arm for surface forces, providing air superiority over the battlespace, close air support, and re-supply missions. The debate would hark back to the arguments of the early forties. Why have a separate air force if airpower is purely a support function for the surface forces?

This hypothetical situation is somewhat analogous to today's space operations.[15] As mentioned earlier, space forces exist today to support terrestrial forces. However, the realization of space force application and space control (akin to air superiority) capabilities, like airpower's development, would present spacepower with its own *raison d être*, thereby making the establishment of a separate space force a possibility.

Summary

Spacepower seems to be mimicking the development of airpower. Extrapolating the analogy, the importance of spacepower will rise accordingly. Airpower's rapid rise to dominance as a form of warfare was due to the unique advantages that vertical positioning, speed, and eventually range, gave to the warfighter. From their early military uses as observation and reconnaissance platforms, both airpower and spacepower continue to evolve. Airpower gained its present status as a separate, and some would argue dominant, form of warfare through technologically developing its offensive capability. Similarly, spacepower could one day achieve such status given technological innovation, as well as political will. The similarities between airpower and spacepower developments seem to suggest that spacepower will evolve into a dominant military force in the future.

PHYSICAL ATTRIBUTES OF SPACE AND HOW THEY COMPARE TO TERRESTRIAL ENVIRONMENTS

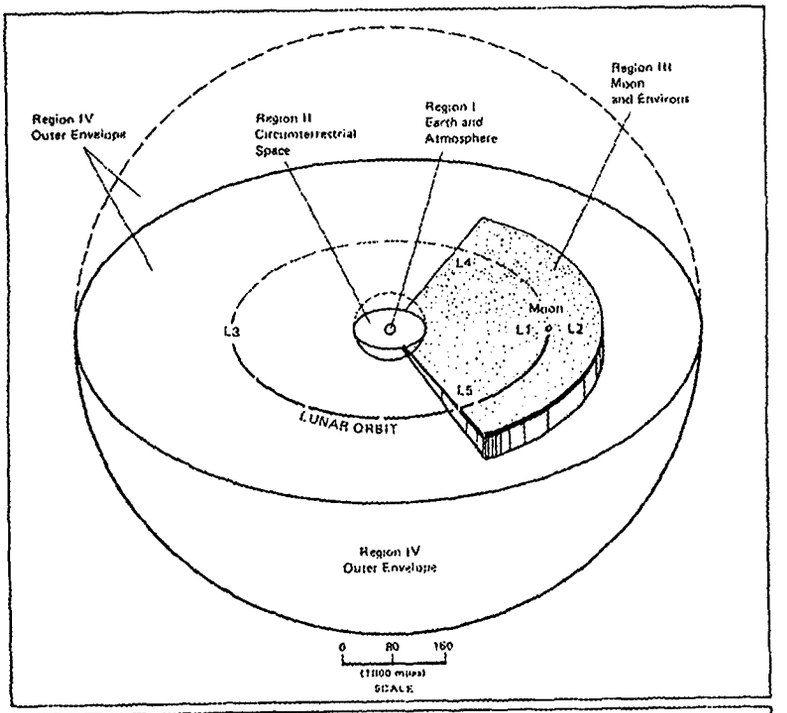
> *National security policy makers, planners, programmers, and operators take geography into constant account, because it exerts strong influence on strategies, tactics, logistics, and force postures. Geography, however excludes most of the Earth-Moon system, which comprises a vast environment loosely known as space.*
>
> —John M. Collins, Report to Congress

This section defines space, discusses the physical characteristics of the medium, and compares these to terrestrial environments. It begins with a discussion of space and such celestial phenomenon as libration points and the gravity well. It concludes by analyzing differences between the space environment and the terrestrial environments in which other forms of military power operate. The attempt is to determine if there are systemic deficiencies which limit spacepower's potential to realize more independence.

Space Defined

A short discussion on what constitutes "space" provides a better understanding of the environs within which the ideas in this thesis pertain (Figure 1). Many sources describe the medium referred to as "space." However, John Collins' work *Military Space Forces: The Next Fifty Years*, discusses it in militarily significant, terms.

> The Earth-Moon System circumscribes four discrete regions: Earth and Atmosphere; Circumterrestrial Space; Moon and Environs; and Outer Envelope. Boundaries are blurred and some attributes overlap, but each nevertheless is individualistic. . . . Earth's atmosphere, gravity, and rotation strongly influence transit between that infrastructure and space. Most effects are adverse, but a few are advantageous.[16]



Distance in miles			
From Earth		From Moon	
Region I	Surface to 60	L1	45,000
II	60 to 50,000	L2	42,000
III	50,000 to 360,000	L3	480,000
IV	240,000 to 480,000	L4	60° ahead of moon
Lunar Orbit	240,000	L5	60° behind moon

NOTE: Regions I, II, and IV are globe shaped. Region III is like a quarter slice of pie, with little depth in comparison. L1 through L5 are lunar libration points.

Figure 2: ***Space Regions and Environs***[17]

There exist in space areas which, theoretically, require little or no energy to maintain position, and from which energy can be used advantageously to affect near-earth space, as well as the Earth, itself. These are termed the libration points. Collins writes:

> The five so-called libration points are not points at all, but three-dimensional positions in space. Mathematical models and computer simulations indicate that free-floating objects within their respective spheres of influence tend to remain there, because the gravitational fields of the Earth and moon are in balance. Spacecraft could theoretically linger for long periods without expending significant fuel. L1 through L3, on a line with Earth and moon, are considered unstable. Objects at those locations, perturbed by the sun and other forces, will wander farther and farther away, if calculations are correct. L4 and L5, 60 degrees ahead of and behind the moon in its orbit, assertedly are stable. Objects at those

> locations probably resist drift more vigorously and, if it begins, remain in that general region.[18]

As in air-to-air combat, the use of "God's G," or converting from a position of relative energy advantage due to high potential energy positioning (high to low), is also applicable to space operations (Figure 2). Military space forces operating from "low" potential energy states in low or near earth orbit, are disadvantaged from those operating farther away—"at the top of the 'gravity well.'" They also experience less maneuvering room and reaction time. Whereas gravity hinders earth to space transit, it helps space to earth flight. "Put simply, it takes less energy to drop objects down a well than to cast them out."[19]

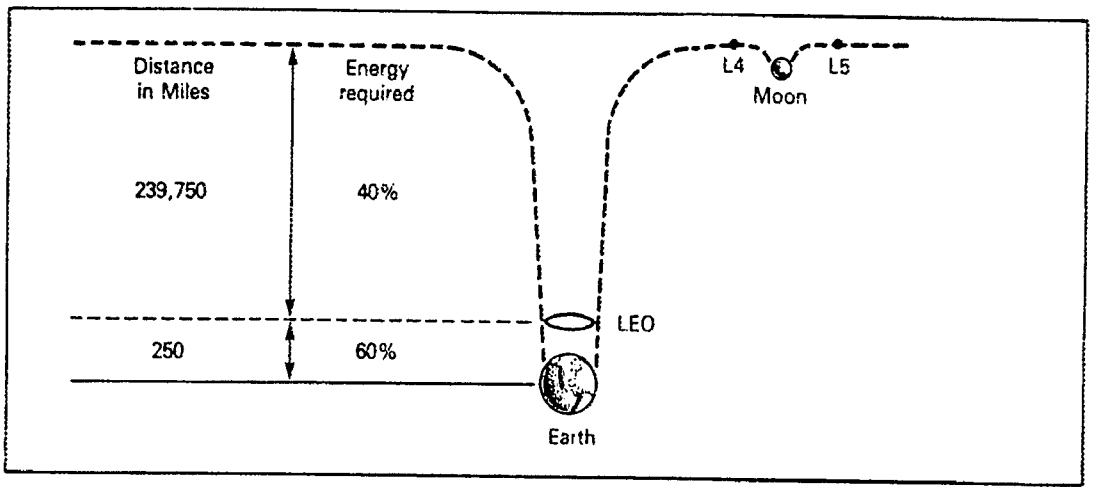


Figure 3: ***Earth and Moon Gravity Wells*** [20]

Obviously, space is a unique operating environment for military forces. Although submariners operate in a seemingly unique environment, they retain standard terrestrial realities as direction and geo-position. Similarly, air forces operate in their own medium, but they too retain many similarities to their sister terrestrial forces, such as direction, geo-position, and constant physical affects of operating within the atmosphere.

Medium Differences

This said, a concise discussion of medium differences may be helpful in grasping the physical uniqueness of space. In his Congressional study, *Military Space Forces: The Next Fifty Years*, John Collins gives a good accounting of medium differences:

> Air, water, weather, climate and vegetation within the Earth-Moon System are exclusively indigenous to this planet. So are populations and industries at present. Land forms and natural resources are restricted to the Earth, moon and asteroids. Cosmic radiation, solar winds, micrometeorites and negligible or neutralized gravity are unique properties of free space. Near vacuum is present everywhere except Earth and vicinity.

> Space and oceans are superficially similar, but differences are more remarkable. Continents bound all seven seas, which are liquid and almost opaque. Topographic features configure ocean bottoms. The Earth's curvature limits visibility to line-of-sight; natural light never illuminates deeply. Water temperature, pressure and salinity anomalies are common.
>
> Space has no north, east, south or west. Right ascension and declination, calculated in different terms than latitude and longitude, designate location and directions. A nonrotating celestial sphere of infinite radius, with its center at Earth's core is the reference frame. Declination, the astronomical analog of latitude, is the angular distance north or south of the celestial equator. Right ascension is the astronomical analog of longitude. The constellation Aries, against which spectators on Earth see the sun when it crosses Earth's equator in spring, defines the prime meridian. Angular positions in space are measured east from that celestial counterpart of Greenwich Observatory.
>
> Distances are meaningful mainly in terms of time. Merchant ships en route from our Pacific coast to the Persian Gulf, for example, take a month to travel 12,000 nautical miles. Apollo 11 made it to the moon—20 times farther—in slightly more than three days.[21]

In short, though it is relatively unique, space is a place—but so is the air, land and sea.[22] Air and space share some similar advantages, specifically, vantage point and speed of access to the surface. The difference between the two on those grounds is simply a matter of degree. Continual operations in both media require countering the force of gravity. In the air, this is generally done by buoyancy, such as lighter-than-air operations, or by lift, via lifting bodies and thrust—but not by speed because of the frictional drag and heat of the atmosphere. Conversely, in space the effects of gravity are countered by speed and position, the required speed being determined by altitude above the earth's surface.

In the air, below 20 miles, the vantage point and speed of access are not as great as they are in space—above 100 miles. But in both media, the vantage point increases as one gains altitude. There is a large difference in the speed of access between air and space—for semi-global distances, the access time through the air is a fraction of a day, but through space it can be

fractions of an hour. As one goes higher in space, one trades speed of access for vantage point—until one reaches the maximum vantage point for specific operations.

The military significance should be obvious: vantage point and access allow observation, communication, navigation, and if developed, force application. The air provides an order-of-magnitude increase in line-of-sight coverage for any place on the earth's surface. Space provides yet another order-of-magnitude increase in coverage over that. Speed of access is militarily important because it allows operations inside the response times of adversaries. To develop optimal speeds of access, one must operate in space to avoid air friction. RAND Corporation's Carl Builder claims: "If observing, communicating, and navigating [and if possible, applying force] is important to militaries, space is the dominant medium." Builder concludes:

> So space is an important military medium for the same reason that air is an important medium, except multiplied by another order-of-magnitude. Space provides for unprecedented vantage points and speeds of access. Those qualities are not essential to all military activities, and there are significant costs associated with operations in space, so the air, land and sea will remain important media for many operations. But wherever vantage point and speed of access are critical aspects of military operations—space will be the dominant medium.[23]

Summary

Physical attributes of the space medium exhibit nothing that systemically, or inherently, limits it as compared to other warfighting media. Space is a medium somewhat unique from other warfighting media. Certain aspects of space allow advantages when operating within it—though other space aspects tend to be detrimental. Libration points allow for little or no energy expense for station keeping, while operating from atop the "gravity well" allows for high potential energy positioning. Differences between the media are noted, as are similarities. The terrestrial medium most similar to space seems to be the air. Vantage point and speed of access are shared physical

characteristics of these media. What, then, makes space special? It is the order-of-magnitude advantage gained over the air in vantage and access—but only when these qualities are militarily required.

CHARACTERISTICS OF MILITARY POWER AND SPACE FORCES

We should on all occasions avoid a general Action, or put anything to Risque, unless compelled by a necessity, into which we ought never be drawn.

—George Washington, 1776

The essential ingredients that lead to an expanded role for space are coming together.

—General Thomas Moorman

Previous discussion demonstrated spacepower's current subordinate position in regard to the other military powers, but it also illustrated spacepower's potential given current technologically feasible capabilities. Upon recognizing its subordinate position and superior potential, the next step examined physical differences and similarities between the military operating media. From that background, this section combines these concepts by comparing military power characteristics of terrestrial and space forces. The general characteristics include strategic agility, ability to demonstrate commitment and credibility, economic considerations, military considerations, and political considerations. To conclude, the relationship between these characteristics and political flexibility is discussed. Ultimately, this comparison demonstrates whether spacepower is limited by any inherent, systemic inadequacies.

Military forces are often compared in various ways, but its the comparison of *real politik* characteristics which generally carries the day. Unique equipment, operating mediums and doctrinal differences are common parameters for comparison, but such analysis is often incomplete, as seams between military forces are typically unclear. For example, airpower connotes abilities of multiple military forces employing various types of equipment, for numerous doctrinal reasons. Herein, forces are compared based on perceived political applicability. At the

end of the day, it is the political applicability of a force, not operational dissimilarities from another, which is most meaningful.

Airpower as Part of Terrestrial Military Power

Airpower's characteristics are discussed as part and parcel of terrestrial military power characteristics because airpower's medium is limited in many of the same ways as ground forces and naval forces. Though airpower has one great liberating characteristic from other terrestrial forces—elevation—due to atmospheric (drag, gravity, etc.) and geopolitical limitations (overflight restrictions, basing concerns, etc.) it is similarly limited.

Due to elevation, airpower can rapidly mass large quantities of power anywhere in the world, treaty limitations not withstanding. It can attack strategic targets which surface forces cannot. However, it remains terrestrially limited, as compared to spacepower, by footprint size, geopolitical concerns, and persistence. Another observer has noted: "In addition, just like surface forces, political restrictions could determine where aircraft flew, when, and for what purpose." He points out that, seventy-five years later, airpower remains similarly limited. His paper discusses airpower advocacy pitfalls, as well as the evolutionary, or revolutionary, questions senior leaders dealt with in determining the viability of a separate aviation service. The important conclusion, however, is that:

> separateness does not equal singularity. Wars are fought in many ways with many weapons. Seldom is one service used to wage a campaign or war, although one service may be dominant in them. The nature of the enemy and the war, the objectives to be achieved, and the price willing to be paid by the people will determine what military instruments will be employed and in what proportion.[24]

Characteristics of Military Power

Regardless of the type of military power considered, they all share common characteristics which represent, in the author's view, diverse considerations capturing the essence of military power. They are diverse, yet interrelated, which reflects the association between military power and political will. It is this relationship which, in the end, determines the usefulness of any form of military power in any given situation.

The characteristics of military power include strategic agility, ability to demonstrate commitment and credibility, economic considerations, military considerations, and political considerations. The application of these general characteristics change as the status of forces changes from being homebased, to deploying, to engaging in combat. (Homebasing does not imply US basing. Rather, it denotes a force located in its primary position, with all of its required logistics for permanent operations and sustainability. A fighter wing is homebased if it is at its primary location, e.g., Lakenheath, United Kingdom, whereas a carrier battle group is homebased if it is totally integrated and sustainable—theoretically, this could be "on station.") All of these characteristics are essential to determine the political flexibility of applying the military element of power. Basic definitions of each characteristic follow. *Strategic Agility* refers to the ability to respond rapidly, over global distances, with appropriate capabilities to carry out operations in support of US international interests.[25] This concept takes on even greater import as US forces are restructured and decreased, while US global interests, and possible trouble spots, increase. Various "futures" studies have noted the probability of multiple conflicts in various stages of resolution, occurring in areas around the world vital to US national interests. Hence, the ability to respond rapidly anywhere in the world with appropriate force is a basic requirement for effective military response, and is therefore within the US national interest.

The terms *Commitment* and *Credibility* go hand-in-hand. Commitment refers to the state of being bound emotionally, or intellectually, to a course of action or ideal. The dictionary refers to it as a pledge to act, while credibility takes this concept another step by making this commitment, or pledge to act, plausible. For instance, the perceived capability of US assets makes the actor the US wishes to influence believe the US will act on a notion of international interest.[26]

In the past, these terms have been closely identified with the concept of deterrence. Thomas Schelling, in his work *Arms and Influence*, talks at length about what he terms "The Art of Commitment." He frames his argument in terms of the Cold War, and posits that an adversary must be communicated with effectively in order to realize one's strategy. If a country has gone to great lengths to influence an adversary, but has not communicated its commitment or credibility to act, then it has failed—the adversary remains uninfluenced. Interestingly, in the Cold War paradigm, Schelling suggests that in order to effectively communicate with an adversary its commitment and credibility, the country must physically, or morally, put itself into a situation from which its only rational act would be to act. In his words, "Just saying so won't do it. What we have to do is to get ourselves into a position where we cannot fail to react as we said we would—where we just cannot help it—or where we would be obliged by some overwhelming cost of not reacting in the manner we had declared. Often we must maneuver into a position where we no longer have much choice left. Thus is the old business of burning bridges."[27] The paradigm of conventional terrestrial force commitment and credibility has always included the notion of putting forces at risk to make a point. This approach remains valid today.

However, this thesis suggests not an alternative solution, but a unique application of these concepts as applied to an adjunct force. Such a force could demonstrate commitment and credibility for less Machievellian reasons. If a force were "easy" to use—economically, militarily,

and politically—it would be engendered with commitment and credibility. The adversary need not consider that US personnel and equipment are at risk to prove credibility and commitment; rather, these concepts would exist by US capability to apply force with little regard to risk of any kind. This virtual lack of risk, then, becomes the mechanism to convince adversarial leadership of US ability and willingness to act. This "Third Wave"[28] concept is the antithesis of the Industrial Warfare paradigm of proving commitment and credibility through putting one's forces in harm's way.

Economic Considerations: A discussion of the myriad of issues involved in the fiscal realities of military forces is beyond the scope of this thesis. However, to narrow the focus for this paper, the USAF seems to believe the basic economic consideration for military forces is the ability to efficiently allocate resources required to deploy and employ capabilities.[29] Military forces are expensive and, generally, their size and capability demonstrate the vastness, or lack thereof, of a country's treasure and international stature. One need only refer to present day media to discern the immense amount of fiscal resources involved in fielding a credible and able fighting force. As the US downsizes its military and takes advantage of the "peace dividend," the susceptibility of US forces to physical loss or damage, or increasing expense involved in deployment and operations, weighs heavily into political decision making. When comparing forms of military power by economic considerations, many variables exist. Susceptibility of forces to loss or damage, research and development costs, acquisition costs, sunk costs, operational costs, and associated costs (manning, infrastructure, etc.) are all considerations.

However, when considering the economics of military force, one must realize forces are bought and exist for two basic purposes—as diplomatic tools and to provide national security. If national security is at risk, or serious diplomatic endeavors are in jeopardy, many of these cost

issues may become insignificant. For example, if forces were used in the interest of a close ally, or for operations upon which monumental national economic priorities exist, economic arguments against using such force may be mute. This said, though, if the same effects could be rendered by an adjunct force with fewer risks, regardless of diplomatic or national security priorities, this would seem advantageous.

Military Considerations: This concept is closely associated with economic, as well as political, considerations. The susceptibility of a force to degradation or destruction is the measure of its military vulnerability. As the USAF defines it, survivability is key, that is, the ability to limit risks.[30] For a deployed force, this plays heavily into command planning functions.[31] Other considerations include, training, replacements, loss rates, family considerations, media relations, unit cohesiveness, and coalition dynamics, to name a few.

Aside from these "negative" aspects, military forces are built and maintained with one mission in mind—warfighting.[32] As discussed previously, this mission relates to two objectives—diplomatic utility and national security. Sufficient numbers are planned for attrition, and advancing technology is offered to increase force effectiveness, though fiscal realities makes such planning increasingly problematic. Quality and effectiveness are hallmarks of US military forces, though certain contingents cast counter dispersions. Many quarters prior to the Gulf War were doubting the effectiveness of high cost US weapon systems. Such contingents were noticeably quiet after the war ended and US technological superiority was widely recognized. The US military has generally had quality training and equipment to meet most contingencies—but such assets cannot makeup for fallacious policy.

Political Considerations: The effect of the above considerations rest firmly on the political fulcrum. As economic and military considerations ebb and flow, so too do a nation's

political considerations. A nation's political fortunes are closely tied to its economic and military robustness. Hence in the end, the susceptibility of a nation's economic health and military power to degradation affect the nation's political viability. This interrelationship is one of the most critical and absorbing problems of statesmanship—it involves the security of the nation and, in large measure, determines the extent to which the individual may enjoy life, liberty, prosperity, and happiness.[33] Other valid political considerations include, media relations, public relations, and world geopolitical dynamics (alliances, coalitions, neutral, gray, third party states and enemy states).

Regarding the counter argument, a successful military operation generally results in great political benefits, thereby mitigating any negative considerations that may have existed. For example, President Bush was inundated with cautious overtones from many political quarters prior to the beginning of hostilities in the Gulf. Many deemed the political considerations of such an operation too costly. However, after successfully engaging his forces, the same man was regaled from the same quarters, and more, for his astute statesmanship and political guts. The president's polls were the highest of any president in recent memory—some showing approval ratings as high as 90 percent. Politicians can ride the wave of popularity following successful military operations, or can be swept up in the despair of a nation which uses its forces less than effectively.

With these basic definitions in hand, this paper now considers how each characteristic applies to forces on a continuum of deployment. Terrestrial force characteristics are discussed as the force moves from homebase to deployed and engaged states. How these same characteristics apply to two variations of space forces—current fielded forces and current technologically

feasible forces—are then discussed. The first analysis is made of a terrestrial force located at its homebase.

Terrestrial Force Characteristics

Homebased Forces:

Terrestrial Power Characteristics

↑Strategic Agility

↓Commitment/Credibility

- Economic Considerations

- Military Considerations

- Political Considerations

Home **Deployed** **Engaged**

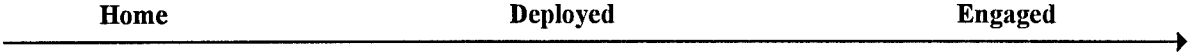


Figure 3: Continuum of Operations and Characteristics of Homebased Terrestrial Forces

Note: The use of arrows in Figures 3 through 7 are meant to indicate the significance of the issues associated with them. While ↑Strategic Agility means increasing strategic agility, and ↑Commitment means increasing commitment, ↑Economic, Military, or Political Considerations means that the considerations discussed are of heightened importance.

Terrestrial Homebased Forces & Strategic Agility

Generally, a terrestrial force enjoys its maximum responsive capability when based at home. Upon receiving mobilization orders, and generating to deployable status, the force is ready to be deployed anywhere in the world at varying rates. Obviously, ground forces must be either airlifted or sealifted to an area of concern, and this process takes time—given a relatively large force commitment, this period could be weeks to months. Naval assets, depending where they are located when the decision is made to deploy them, are available anywhere from within hours to days to weeks. Generally, to generate a large enough force to be decisive in any contingency, the

deployment time will be days to weeks for naval forces. Wings or squadrons of fighter, attack, bomber, or reconnaissance aircraft can be in place with large amounts of firepower within a theater of operations in probably the shortest period of time—within hours to days. Note "at home" for a naval carrier task force could in reality be "deployed," if such a force is integrated and sustainable in its location. If this force is not located at exactly the proper spot, relocating such force could take days to weeks. Sustained operations require arrival of more combat and support forces. However, naval forces themselves have theoretically indefinite sustainment capability given effective replenishment.

Terrestrial Homebased Forces & Commitment/Credibility

On the other hand, while terrestrial forces remain at home, the commitment of the nation to respond to a crises and its credibility with its alliances/coalitions, and its adversary, is at its ebb. The nation's potential adversary may remain unimpressed and affected by only whatever diplomatic rhetoric is exchanged. Even if the rhetoric includes outright or veiled threats of military response, the adversary may not perceive the intention of the communication. A force still at home may demonstrate an unwillingness to react militarily. (Nuclear alert forces are the exception, albeit a large one.) The reasons for non-reaction could be many, most of which could actually be valid domestic, national, or international concerns. However, the perception by the concerned parties is the same—a fundamental lack of commitment and credibility of the nation to react with sufficient force to stem the tide of an international event.

Terrestrial Homebased Forces & Economic Considerations

Economic considerations for homebased forces tend to be neutral. Generally, the cheapest basing mode for a terrestrial military force is while it is at home. While units are at the homebase

they subsist on a system that is integrated, streamlined, and reasonably efficient. They train effectively and efficiently based on many years of experience. Historically, accidents resulting in dead and injured personnel, as well as destroyed and damaged equipment, are lower while a unit is homebased.[34] The personnel and equipment are maintained most efficiently in this mode as well. The result is that national treasure remains relatively unaffected. The force is maintained within budgetary constraints mandated by government, and no "surge" funding is required to meet unanticipated needs. The force is most easily maintained combat-ready at home.

The exceptions to this concept include possible funding of US operations by another party, though historically, few operations involving US forces have been sufficiently funded by another party to negate a loss to US budgets. At times, training experience can be better at deployed locations, e.g. Red Flag, though records indicate loss rates are generally higher. However, higher loss rates do not necessarily negate the value-added of such training. Another exception is that homebased forces could be attacked either by another nation's forces, by unconventional warfare, or by terrorists. If attacks on homebased forces are broad, well targeted, and successful, the economic impact on the nation could be quite immense. However, if such an attack were to escalate into a war with the nation's survival at risk, the impact on the nation's economy by an attack on its homebased forces would be a relatively minuscule concern.

Terrestrial Homebased Forces & Military Considerations

Military considerations for homebased forces tend to be neutral as well. Obviously, the susceptibility of a terrestrial force to damage or defeat is almost non-existent when it remains at home and the country is not at war. On the other hand, it is usually not operationally viable in such a position. (Exceptions include carrier task forces and certain airpower capabilities.)

Military assets, both personnel and equipment, are in their least susceptible state when based at home. The exception to this concept would be a nation that experiences attacks on its military forces within its own borders. In this instance, the fact that forces remain in an undeployed state actually makes them more liable to degradation from an attack, and the chance that the force will be degraded or destroyed is higher than if the forces were deployed. The military impact of such an occurrence could have drastic consequences. If the attack was but a prelude to a full scale war with the nation's survival at stake, the impact of the susceptibility of the nation's forces to such an attack would be great indeed.

Terrestrial Homebased Forces & Political Considerations

As economic and military considerations remain neutral for homebased terrestrial forces, so too do the political considerations. The susceptibility of the nation's political realm to domestic as well as international outcry and indignation is low—so too is the chance for great political windfall given a successful military operation. As a result, the political leadership of the nation remains relatively flexible in their use of terrestrial armed force. For example, there is often little public outcry as homebased military forces are mobilized to help with natural and man-made disasters.

Considering the exception, as noted in both the terrestrial force economic and military considerations discussions, if the homebased force were to suffer degradation or destruction from an attack, political considerations could skyrocket. Again, if the nation's existence was at stake, this would be of little regard. However, if the attack was but a nuisance operation to demonstrate resolve or capability, the leadership of the nation could experience great disrepute. The dangerous consequence might be an inappropriate use of force in reaction to the humiliation,

thereby escalating opportunities for drastic occurrences. This paper now turns its attention to terrestrial forces in a deployed state.

Deployed Forces:

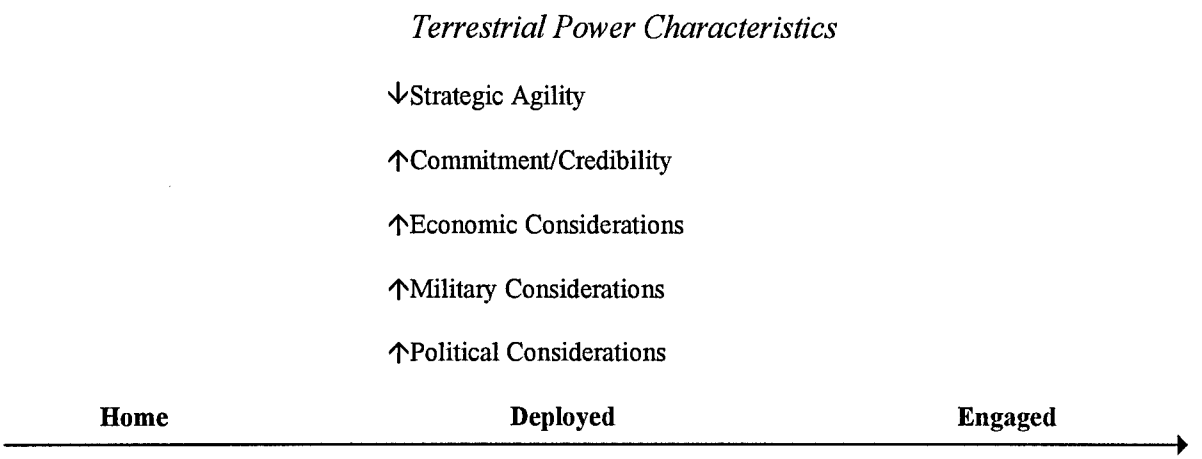


Figure 4: Continuum of Operations and Characteristics of Deployed Terrestrial Forces

Terrestrial Deployed Forces & Strategic Agility

As terrestrial forces leave their homebase and are committed to a theater of operations, their capability of redeploying to yet another theater decreases. There are many aspects to this dilemma. First, if a force is committed to a theater to carry out the wishes of its political leadership, the wish to relocate it supposes a severe reason to do so. Doing so may result in unachieved objectives in the original theater. Second, as US forces are drawn down, the amount of force required to effect desired outcomes becomes critical. Theoretically, if just the right amount of force exists in a theater, moving any of it to another theater could result in either defeat or unwarranted losses in both theaters. Third, once a force is deployed and in place, it becomes physically difficult to relocate it to another area by virtue of logistics requirements.

Terrestrial Deployed Forces & Commitment/Credibility

As US forces are deployed into harm's way, commitment and credibility of US resolve increases. Friends and enemies alike realize the significance of US leadership deciding to jeopardize personnel, equipment, national treasure, and domestic and international goodwill by sending forces into a theater of operations. The deployment of forces heralds the increased capability of the US to react. It is the perception of this increased capability that is the bulwark of demonstrating commitment and credibility. The perception of US resolve, both by friends and adversaries, is greatly increased by the deployment of forces.

Terrestrial Deployed Forces & Economic Considerations

As forces are deployed, economic costs of all kinds tend to increase. No longer is the force sustained by a system whose efficiency has been honed through years of use. Field conditions demand additional housing, food, water, transportation, medical care, maintenance, etc. as these functions must now be afforded apart from an established base. The force cannot necessarily be maintained within its legal budgetary constraints. The possibility of additional funding to ensure adequate operations increases dramatically.

Historically, the accident rate for military forces increases as they deploy into unfamiliar territory. Emotions run high, units tend to train more "realistically," crews are not operating in territory or under conditions they are used to. In such a state equipment tends to break down and personnel tend to be injured or killed more than when forces are homebased.

Maintenance of equipment becomes more expensive and problematic at deployed locations. Major and minor maintenance on equipment becomes more difficult. Depots exist half a world away, and industry technical representatives are not always immediately accessible.

Equipment is fixed with what was brought with the force. If the proper tool or part is not available, the entire system remains unusable. Inefficient transportation practices are put into use to field important parts and ensure rapid repairs. Cost increases as the distance from the homebase increases for terrestrial forces. These costs are varied and span the spectrum of military requirements.

It can be argued that economic considerations would be of no import if the act of deploying forces deterred war. This would be true given an electorate fully cognitive of essential facts, and politicians willing to risk such an act. Given a situation where deployment of forces successfully deterred war, even though costs were high in men, equipment and treasure, it would be difficult to prove that it was simply the act of deploying such force which resulted in peace. In fact, such a situation seems much too simple. Even with deployed force, it remains the dynamic of diplomacy which results in peace. With US media coverage, the loss of treasure, men and equipment would be on the mind of Americans, even though peace may be at hand. However, if one considers military forces exist to fight, and fighting generally connotes deployment of US forces, and deployments generally connote economic losses, which are therefore accepted, this argument falls apart. In other words, a nation cares little of losing national treasure if forces are properly deployed and engaged with successful results.

Terrestrial Deployed Forces & Military Considerations

The susceptibility of US terrestrial forces to attack, and therefore degradation or destruction, increases as the force deploys to a theater of operations. Forces are outside of the protective boundary afforded by US airspace and sea buffers and are nearer the enemy forces' capability to strike. Terrorist or unconventional warfare forces can also attack with greater ease

once US forces arrive in theater. As with economic considerations, as the distance increases away from home base, the military considerations of US forces increases. Both of these considerations affect US political considerations as well.

However, this susceptibility may be a mute consideration if one considers that military forces exist to fight, and fighting US forces generally requires deployment, and deployments tend to risk degradation and destruction. With such a notion, the fact that military forces may be degraded or destroyed has little or no significant impact on the decision to use them—for they exist to be used. The risk of their destruction or degradation is of little significance, the argument goes, because such problems have been planned for in force structure and effectiveness decisions. Hopefully, the planning has been accurate. Such an argument has some validity.

Terrestrial Deployed Forces & Political Considerations

If deployed US forces demonstrate heightened importance of economic and military considerations than when they are at home, then so too do US political leaders' considerations increase in significance. If US national wealth becomes susceptible to increased diminution, and US personnel are put at increased physical risk, US political leaders begin to walk a fine line as they carry out national policy by using terrestrial armed forces. It can be argued that this point is only true if the political objectives for deploying forces are not achieved. If they are achieved, it is argued, the deployment of forces actually allows for the potential of enormous political gains. The question that must be answered for this point to be valid is, "Are politicians willing to take this risk, based on recent deployment track records?" If US public opinion still had events like Vietnam, Desert One, Somalia, or Bosnia on its mind, this line of reasoning seems debatable.

Events such as Haiti and Grenada could be looked at either way, while the result of Desert Storm could support this latter line of reasoning.

Engaged Forces:

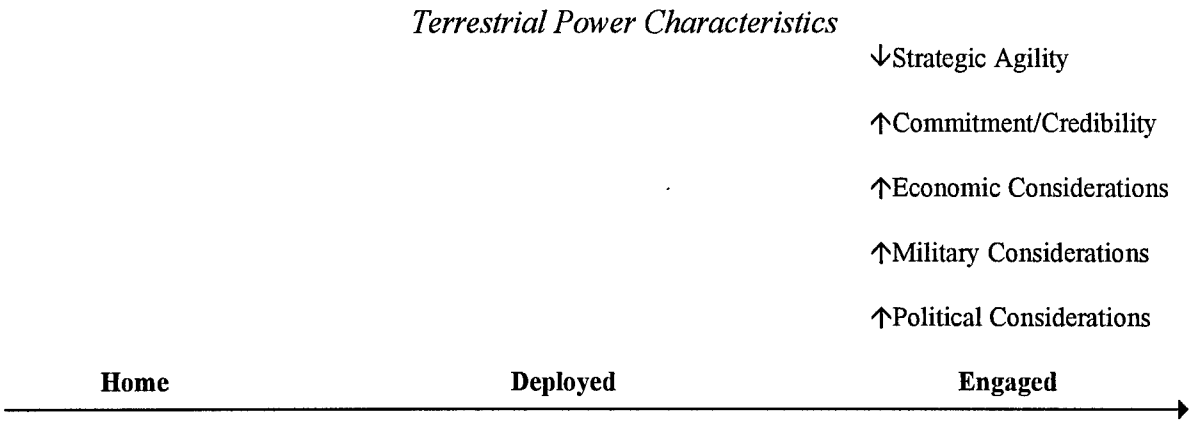


Figure 5: Continuum of Operations and Characteristics of Engaged Terrestrial Forces

Terrestrial Engaged Forces & Strategic Agility

Engaged force characteristics tend to mimic deployed force characteristics, but with greater impact. The concept of decreased strategic agility that held for deployed terrestrial forces holds true for engaged terrestrial forces as well. However, the extent to which strategic agility is decreased is exponentially larger. It becomes much more difficult to move terrestrial forces to another theater once they are engaged. The problems of just disengaging the forces are so immense—politically, militarily, and logistically—as to prohibit the thought of redeploying them elsewhere.

Terrestrial Engaged Forces & Commitment/Credibility

Commitment and credibility rapidly and exponentially rise when forces are engaged in combat. The adversary, as well as alliance partners, become strong believers in US resolve. The

ultimate expression of resolve is to put national resources, such as humans and equipment, into direct contact with the enemy.

Terrestrial Engaged Forces & Economic Considerations

Unfortunately, as commitment and credibility rapidly increase as forces come into contact, so too does the susceptibility to losing vast amounts of national wealth. Present and future weapon systems are exceedingly expensive, and operators of these systems are ever more highly trained. The economic impact of their losses is great, and the chances that this impact will be felt rises rapidly as terrestrial forces meet the enemy. War is always costly, but it continues to be waged because sometimes costs of not waging it are exceedingly high. The other counter arguments remain the same as for deployed forces. The point is, however, that if these considerations and costs can be mitigated, they should be.

Terrestrial Engaged Forces & Military Considerations

As with economic considerations, the susceptibility of losing military forces is exponential once rounds begin to be exchanged in the terrestrial battlespace. As weapon systems become ever more complex and expensive, their numbers dwindle. Therefore, each one becomes that much more militarily valuable. The loss of each system, and/or the highly trained operator, is that much more militarily significant. On the other hand, such systems and soldiers are meant to fight, therefore their loss is generally accepted as attrition, and properly planned for in force structure debates. Hopefully, this is true, and the planning is accurate.

Terrestrial Engaged Forces & Political Considerations

As with the previous discussion, the political vulnerability associated with forces engaged in combat is quite high. The moral and economic impact of one's forces engaged in combat bring with it a high susceptibility of political leadership to ridicule and blame. As American mothers' sons and daughters are injured and killed, and media coverage of civilian casualties, and even large amounts of enemy troops, is broadcast into American homes, domestic moral outrage could be quite high. Even without a protracted conflict to drain US coffers, domestic opinion of losing large amounts of high cost weapon systems will begin to emerge. The sum of this discontent will fall squarely on the shoulders of US elected officials—most of whom are interested in continued employment and prestige.

Obviously, this applies only to perceived losers. President Bush's 90 percent popularity rating in the wake of the Gulf War is evidence of the enormous political boon "winning" entails. The question remains, however, are most politicians willing to take such a risk? The US was considered the out-and-out winner in Kuwait, but what were public perceptions regarding Korea, Vietnam, El Salvador, Desert One, Panama, Somalia, Bosnia, etc.? It seems that wildly successful campaigns are far outnumbered by perceived questionable or outright poor results.

Comparative Spacepower Characteristics

With all of this said about terrestrial force characteristics across the spectrum of deployment, how are spacepower's characteristics affected on this same continuum? Where does spacepower fit on this continuum? Certain space forces constantly exist somewhere between the deployed and engaged states. This assumes the asset is successfully launched and placed into

proper orbit, or is capable of transiting the proper orbit inherent in carrying out its mission.[35] In such a location, the asset is deployed. From such a deployed location, the asset can engage.

A case could be made, however, that space assets are always engaged. This concept stems from the idea that spacepower, due to its position, is constantly present in the mind of allies and potential adversaries. Force can be immediately, or relatively rapidly, employed in concert with or against an actor—either virtually or really (much like terrestrial nuclear alert forces). This concept is termed Presence.

The question for spacepower today is what forces can be brought to bear? What capabilities are "present" in the mind of the actor? As previously discussed, spacepower is limited today in what "force" it can provide. This limitation, however, is not due to technological limitations as much as political considerations. Regardless, the limits are real. Such limitations, however, do not negate the applicability of this analysis. To the contrary, this analysis may demonstrate the advantages of fielding such capabilities. In order to demonstrate this, military force characteristics will be discussed as they apply to spacepower both in current capabilities and in technologically feasible, projected capabilities. The delta between these variations could demonstrate the advisability of pursuing current, technologically feasible capabilities from economic, military, and political standpoints.

Space Forces & Strategic Agility

Being forward deployed, and due to physical capabilities associated with the medium, spacepower entails a responsive capability. Satellites in geosynchronous orbit can maintain a constant presence over a specified area for years at a time. Even in low-earth orbit, constellations of satellites could work in unison to effectively influence areas separated by vast overland

distances. Satellites can also be moved. Though today this process is slow and expensive in fuel requirements, technological developments in solar energy collection, conversion, and storage offer new possibilities. The size of satellites is also being reduced, correspondingly reducing the energy requirements to make them maneuverable. Additionally, concepts of directed energy transfer and reusable launch vehicle re-supply are on the drawing board or in development. The vantage of space allows a broad footprint that continues to grow and be more maneuverable. Even if moved only degrees per day, that footprint casts a large effective area relatively rapidly.

Given today's standing space force agility capabilities described above, as well as emerging capabilities, no longer would the US military, and policy makers, be restrained from engaging elsewhere when their forces are deployed or engaged in one area of the globe. US space forces retain strategic agility to affect virtually any area, any time. This agility is conditional, however. It depends on the degree to which the particular space force resource is designed to operate. If the resource is self-reliant, or not supporting a terrestrial system, it maintains its maximum agility. If the system supports a terrestrial system, e.g. cueing sensors, it then is limited by the terrestrial system's agility, unless it retains a capability to support multiple, geographically-separated terrestrial systems.

Except for current systems already on orbit, much of this argument is mute if the US does not pursue technologies now in development to ensure rapid, responsive, affordable space lift. Without a capability to place forces into proper position rapidly and affordably, be it orbital or suborbital, spacepower's strategic agility is limited to present on orbit assets. Shuttle missions to repair satellites or place assets in orbit are prohibitively expensive and time consuming, thereby driving up economic, military and political considerations.

Space Forces & Commitment/Credibility

On orbit space forces can be thought of as always deployed, or in certain instances, even engaged. Given space assets which are technologically feasible today, the commitment and credibility of such a force is inherent. Adversaries no longer need question US commitment. No longer do costly deployments of personnel and equipment need be carried out in a show of force. With spacepower, the force exists on station, all the time, or at least can get on station very rapidly—depending on space force basing modes. The paradigm of putting forces at risk is replaced with the notion that exactly because forces are not at risk, the plausibility of use of such force increases, thereby increasing the notion that US policy makers will use it—commitment and credibility.

The degree of commitment and credibility, however, is limited by today's actual space forces. The lack of an autonomous force application capability to directly influence an actor mitigates the forces' ability to demonstrate commitment and credibility. (This capability need not even require kinetic or directed energy weapons; information warfare systems would be sufficient, perhaps even superior. In this information age, such systems could influence just as well, if not better, than more conventional type weapons.) In other words, though certain space forces are in the mind of the actor (reconnaissance platforms, for example), their lack of ability to directly influence requires the old paradigm of putting terrestrial forces into harm's way to demonstrate US commitment and credibility.

Space Forces & Economic Considerations

Today's actual space forces, as well as those technologically feasible, do not require escalating support and operational costs upon deployment and engagement (as do terrestrial

forces). The majority of spacepower costs are those incurred as sunk costs, that is paid at, and prior to, acquisition. Maintenance costs and life cycle costs can be drastically reduced with a lift capability allowing either on-orbit replenishment, or rapid, contingency-oriented delivery capability, such as a Transatmospheric Vehicle or a reusable Single Stage To Orbit system.[36]

The costs of attack on homebased spacepower resources depends on the systems' basing modes. Orbital systems, obviously, are least affected by such an attack, unless the systems are singularly tied to, and reliant upon, a ground based station. Reusable systems are most vulnerable to this situation and efforts are required to minimize this chance. Today's fielded technology presently requires widely dispersed ground stations, some well outside of the protective boundaries of the US. This presents a significant security problem for today's US space assets. Considering the presently available technology, such bases could be maintained well inside US territory, allowing worldwide control via constellation interconnectivity and providing maximum security.[37]

Problems with space forces include their extremely high initial cost. The loss of one such asset would be felt much deeper than the loss of multiple terrestrial force resources. This fact calls for the early establishment of a space control capability to ward off such possibilities. As with airpower, superiority of the medium is crucial to the ability to operate from the medium. It also calls for rapid realization of cheap, responsive lift to ensure assets achieve position safely.

Space Forces & Military Considerations

Like homebased terrestrial forces, the susceptibility of spacepower assets to damage or defeat is relatively lower than deployed or engaged terrestrial forces. This implies a US space control capability to negate any space-borne, or surface-based capability against US space

systems. If the US would attempt to influence a space-capable actor, that actor's possession of an anti-satellite weapon could negate the concept of US spacepower's lowered susceptibility to degradation and destruction. Such an anti-satellite system is technologically feasible today, though unclassified sources assert that none have been fielded. Additionally, as previously discussed, minimizing foreign ground stations can negate security problems. Technologies presently exist to minimize this risk, allowing ground stations to be located within the contiguous US, relaying data along constellations.

Tied directly to economic considerations, relatively fewer space assets can be deployed as compared to terrestrial assets. This is due to high cost, as well as multiple-capability characteristic of space assets. Both of these issues could cause the loss of just a few space assets to adversely affect military operations—much more so than the loss of similar numbers of terrestrial assets. Again, such a fact harkens the need for early space control capability.

Space Forces & Political Considerations

Due to the relatively low economic and military considerations spacepower resources enjoy, as compared to deployed and engaged terrestrial forces, the political repercussions of utilizing such assets is correspondingly lower. Whereas policy makers have to contend with possible loss of troops' lives when considering deploying or engaging terrestrial forces, the use of space forces carries no such political liabilities when considering unmanned assets, and little chance of political liability when considering manned assets. As Major General DeKok, Air Force Space Command's Director of Operations and Plans, remarked, "Satellites have no mothers."[38]

Given today's technologically feasible capabilities, as well as today's fielded systems, the inherent lack of political problems with using spacepower is instrumental in making it an

extremely flexible political tool of national power. It can be used with little regard to political ramifications at home in many situations previously deemed as too politically sensitive. National policy decisions no longer need to be restricted by visions of the media displaying dead Marines being dragged through the streets of a foreign land. Spacepower can complement and support the other elements of power while not increasing chances of early US withdrawal due to loss of life or equipment.

On the other hand, as with other considerations, due to economic and military implications of losing just a few space assets, political ramifications of such a loss are high. Space control remains a high economic, military and political priority if deploying a space capability. Today, without this space control capability, political, economic, and military ramifications of losing spacepower advantages to a space-capable adversary could be high. Considering the high degree of space support terrestrial systems have come to rely upon, loss of such capabilities could be disastrous. Additionally, this degree of reliance is increasing.

Analyzing the characteristics of spacepower, there is a clear difference as they apply to today's actual space force and to today's technologically feasible space force. That difference demonstrates the need to pursue the space control capabilities that are technologically feasible. Today's actual space forces have a balance of advantages and disadvantages when compared characteristically to terrestrial forces. Conversely, the space force that is technologically feasible today and in the near future for space seems to demonstrate many characteristic advantages and few disadvantages when compared to terrestrial forces. The comparison of space force and terrestrial force characteristics summarized in Figure 7 assumes that the US pursues the space control force which is technologically feasible.

Overall Comparison

Technologically Feasible Spacepower Characteristics

↑Strategic Agility

↑Commitment/Credibility

↓Economic Considerations

↓Military Considerations

↓Political Considerations

Terrestrial Power Characteristics

Home	Deployed	Engaged
↑Strategic Agility	↓Strategic Agility	↓Strategic Agility
↓Commitment/Credibility	↑Commitment/Credibility	↑Commitment/Credibility
- Economic Considerations	↑Economic Considerations	↑ Economic Considerations
- Military Considerations	↑Military Considerations	↑Military Considerations
- Political Considerations	↑Political Considerations	↑Political Considerations

Figure 7: Continuum of Operations and Characteristics of Spacepower versus Terrestrial Forces

Risk management is the hallmark of military characteristics as they apply to spacepower. Spacepower, due to its inherent characteristics of non-provocativeness of position, decreased economic, military and political considerations, coupled with increased strategic agility and demonstration of commitment and credibility, can act to *influence* entities with decreased risk as compared to terrestrial forces. To a certain extent this is true given today's fielded space systems, though limitations previously discussed, such as a lack of force application capabilities, mitigate some benefits. However, given a space force which is technologically feasible today, the benefits that spacepower brings to the diplomatic forum seem to be great as compared to terrestrial forces

by the characteristics of strategic agility, ability to demonstrate commitment and credibility, and economic, military and political considerations.

Many of the considerations discussed with regard to terrestrial forces were moderated by views that military forces exist to deploy and fight. Such views hold that since this is so, the forces' economic, military and political considerations need not regard their degradation or loss as a primary limiting factor in their use. While this notion has credence, it remains true, it seems, that the ability of an adjunct force to affect an actor in a similar way, but without risking such loss or degradation, has great advantages. Though such a force does not totally exist today, due to spacepower's lack of ability to directly influence an actor, it does not follow that such a capability should not be sought. In fact, from an analysis of military characteristics as they apply to terrestrial forces, today's actual space force, and to a space force technologically feasible today, it seems such a force would be beneficial.

Summary: Political Flexibility

It is said the military is the extended arm and fist of diplomacy. Inherent in this concept is political flexibility to use military force. If the domestic or international political ramifications of using military force are too great, the likelihood that government will resort to it seems low. This notion is modified, however, when considering a fight for national survival or in operations of similarly great import. In other, more routine operations, if left without this sometimes last recourse, government could be left impotent to advantageously influence events, and may be forced to stand by and watch events take place which are against the national interest.

This political inflexibility to resort to using military action results from many factors. Considering recent crises the US has been embroiled in, however, it seems economic, military and

political considerations are paramount. The problems, as well as advantages, inherent with terrestrial forces and these factors have been discussed. It seems, as the probability of actual military confrontation increases, so too do the significance of the considerations. Hence, the political flexibility to use the military instrument tends to decrease. However, due to some of the advantages of spacepower discussed above (tempered by today's limitations, and bolstered by today's technological capabilities), these considerations can be drastically reduced across the spectrum of military action. This decrease allows much more political flexibility, thereby allowing the government another realistic diplomatic tool with which to ensure US national interests are met.

CONCLUSION AND IMPLICATIONS

> *Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur.*
>
> —Giulio Douhet

> *Now is the time to take longer strides time for a great new American enterprise time for this nation to take a clearly leading role in space achievement, which in many ways holds the key to our future on Earth.*
>
> —John F. Kennedy

> *The introduction of new military capabilities often involves a rethinking, a mental jump to entirely new concepts. It is not a question of doing something better, it is a question of doing something different. Not everyone can make this mental jump.*
>
> —General Merril McPeak

This thesis demonstrates spacepower on most counts is not inherently limited. Spacepower has the potential to be a fully functional arm of national military power. However, to realize such benefits, the US must develop doctrine to realize advancing space technologies, thereby allowing full space access and exploitive ability across the mission spectrum. This last section deals with some implications requiring further thought by the US leadership. A basic change of thinking is needed regarding future US space capabilities, both in how we think militarily about space and how we think fiscally about space. US space doctrine, currently reflecting spacepower's subordinate role, could be more forward reaching. Billy Mitchell once remarked about short-sighted doctrine:

> National safety would be endangered by an air force whose doctrine and techniques are tied solely to the equipment and processes of the moment. Present equipment is but a step in progress, and any air force which does not keep its doctrine ahead of its equipment, and its vision far into the future, can only delude the nation into a false sense of security.[39]

Spacepower is Not Inherently Limited

Spacepower has been evolving much like airpower did. Airpower has evolved into a military power capable of the independent application of influential force, while retaining its advantages as an integrated part of the overall US force structure. Spacepower is a viable force today as part of this structure, in that it is used to support all of the terrestrial military arms—and this support is increasing. However, it seems presently stymied as purely a supporting force, with no apparent trend toward realizing greater independent military potential. While early airpower doctrine generally seemed to consider ever greater capabilities than were presently available, today's spacepower doctrine seems to reflect its stymied position. Past and current technological projects, however, seemingly demonstrate greater available spacepower potential.

Space is a physically unique medium as compared to terrestrial mediums. Its physical attributes seem to demonstrate its ability to affect all other warfighting mediums. Its encompassing nature ensures it access to all other mediums, while its ability to exploit gravity, vice fight it, gives it a natural energy advantage over other mediums. Its lack of atmosphere—while limiting in certain respects due to heat, radiation, cold, etc.—allow less energy to be spent for maintaining operational positioning. Airpower's advantages over the other terrestrial mediums include vantage and speed of access. Spacepower realizes these over the other mediums, and over the air as well—an order-of-magnitude advantage. Spacepower's physical attributes, as they compare to other warfighting mediums, belie nothing that systemically or inherently limits its ability to be a military force able to fully function across the mission spectrum.

A comparison of how military characteristics apply to today's terrestrial forces, today's fielded space forces, and today's technologically feasible space forces illustrates a relatively large difference in limitations and advantages realized by one form of space force as opposed to

another. Today's fielded space forces demonstrate certain advantages when compared to terrestrial forces. On the other hand, a comparison of terrestrial forces to today's technologically feasible space forces illustrates a larger number of advantages for the latter. The delta between these two comparisons seems to demonstrate that spacepower is not inherently limited when compared, by military force characteristics, with terrestrial forces. In fact, it seems spacepower can actually be more politically useful in most situations—though it is acknowledged that certain missions will always require the application of other military forces. In other words, though spacepower has the potential to be a leading independent, as well as integrated, element of military power, terrestrial forces will continue to retain their own unique advantages and applications.

Spacepower's current relative position as a military power is not due to inherent limitations. Why has its potential not been realized? If in many ways the medium is physically more capable than terrestrial warfighting mediums, and spacepower technology exists allowing it to be in many ways more useful than terrestrial forces, then there must be something "artificial"—not systemic or inherent—which is limiting spacepower development.

Policy may be the limiting factor. Military forces exist at the direction of policy. Policy is generated within the services, the Department of Defense, and on Capitol Hill. The ramifications of this reasoning go well beyond the pretenses of this paper. In fact, such a line of reasoning seems worthy of its own study. Suffice to say, however, that if spacepower allows military and political flexibility as described here, it seems worthy of a supportive policy which would be to the long term advantage of the US.

Given supportive policy, a force structure should be created that allows both maximum political flexibility and maximum military flexibility—a fully mission capable space force, coupled

with an integrated, well proportioned, terrestrial force. With such a force, the possibility may exist for long term fiscal savings through decreased terrestrial force infrastructure, and long term manpower and equipment sustainment cost savings.

A major policy change such as this seems a long term solution, if it is even probable. However, three major things can be done now to start US spacepower down this road. The first two concepts could turn the tide of thinking about spacepower as a purely supportive force, the latter would allow a more economical transition to a fully functional space force. The first is a required change of thinking within the military about spacepower: it can be used in its conventional, supportive sense, as well as in more unconventional, independent ways, and some information warfare missions seem ripe for such applications. Part and parcel to this first idea, space should be considered its own area of responsibility. Unity of command is essential for the proper planning and conduct of operations within a medium. The third concept is that fiscal realities require a closer military-civilian space industry reliance.

Required Change of Thinking

When research originally began on this thesis, the author believed military space personnel were inexorably committed to pursuing space capabilities, even those far into the future, which were merely supportive in nature. My perception was that USSPACECOM, as well as each of the services' space commands, were vectoring efforts toward space capabilities that would only support terrestrial military operations. It seemed possible that such an approach could result in a loss of future military capability, national technical ability and prestige, and possibly, national security itself.

After conducting research at USSPACECOM, AFSPACECOM, the Space Warfare Center, Sandia National Laboratory, and Phillips Laboratory, it became evident developments to support the type of space infrastructure requisite to realize spacepower's advantages described herein were possible. In fact, such enabling technology as a rapid, responsive, economical, and reusable space lift capability may not be far off.[40] However, throughout the course of research for this thesis, there were those, some with vast amounts of military space expertise, who claimed spacepower would never attain the requisite capabilities to fully exploit the medium. Some within service space commands, especially outside of the Air Force, seemed intransigent on this position. Varied reasons were given for these views, but most included political, as well as technological and fiscal, concerns.

One need only refer to the historical wrangling airpower experienced in its relative infancy to discern the same arguments. There were those in the Great War who continued to disregard airpower's capability as they put gas masks on their ever trusty cavalry horses to ride them into battle. In the thirties, as the strategic ability of airpower became more widely accepted, there was much political discourse about limiting airpower's capabilities for its perceived inherent political and military instability.

Fortunately, there existed professional military airmen whose vision outreached those of the nay-sayers. Though some suffered humiliating career consequences, they aptly demonstrated the effective and efficient ability of airpower to project presence relatively rapidly as compared to other forces of the day.[41]

It seems most of the professional military space cadre realizes the intrinsic value of operating in and from space, just as Mitchell and his ilk realized similar advantages in their day of operating from the air. Personnel within the US and Air Force Space Commands (including the

Space Warfare Center), as well as the other forces' space commands, seem to be moving with the momentum of forward thinking. However, some barriers exist based on the old space-as-support-only paradigm. Though we still face political and parochial barriers to realize the military and political advantages of fully integrated spacepower, at least we are exploring the science, technology and operational concepts necessary to accomplish it. The "progressives" in the "system" seem to be overtaking the sedimentation of the "*status quos*."

Due to fiscal realities of today, and tomorrow it seems, the technological breakthroughs are being, and probably will be, achieved mostly in the private sector. Space is to commercial enterprise today, and more so tomorrow, what the airlines, both cargo and passenger, were to yesterday and today. However, space offers so much more in terms of communications, weather, transportation, and of other areas that commercial concerns are rapidly outpacing military research in the field.

The US must realize the advantages military spacepower offers. Hopefully, this thesis at least touches some salient concepts that demonstrate spacepower's advantages. With these advantages realized, the US can fully integrate its technological and operational biases with spacepower as a dominant factor. Professional military officers have a duty to articulate any particular concept that displays increased military, and therefore political, advantage to their civilian superiors. It is then the politicians' responsibility to ensure US forces are structured in an optimum manner. Such structuring intimates the need for unity of command regarding space.

Space as an Area of Responsibility

High strategic agility for space forces assumes a high degree of command and control. As air forces are centrally controlled, for matters of understanding unique strategic utility and

capability, and decentrally executed, for matters of tactical expertise at the unit level, so too should space forces be controlled. The pervasive capability of limited numbers of space resources in high demand sets up the same logical structure for centralized command and control of space. Overall, terrestrial forces are controlled as part of a commander's area of responsibility. Subjugating high-valued, far-reaching, but limited forces to one commander responsible for a certain theater of operations has been tried and proven, in most instances, to be the most effective means of command and control.

Based on arguments presented in this thesis, a case can be made that space is its own area of responsibility. In fact, the Russian military considers space a distinct *teatr voyennykh deystviy (TVD)*, or theater of operations.[42] If this is accepted, unity of command demands the appointment of a single commander to this area. Requirements of such command generally include expertise, a fully functional and expert staff, and control of proper equipment and infrastructure. Only one such commander fully fits this requirement—Commander-in-Chief, United States Space Command.

As with airpower employment, employing spacepower requires special knowledge and conceptual internalization. The far-reaching, sometimes global, aspects of airpower employment has demonstrated a requirement for leaders, staffs and operators trained to think in such terms. Similarly, assets with spacepower's worldwide capabilities need to be controlled by leaders, staffs and operators trained to think with such vision.

With unity of command regarding all facets of space, coordination of requirements becomes easier. These requirements span the spectrum from operational to developmental. Developmentally, as well as operationally, as the use of space becomes more commonplace, commercial enterprise will have to be coordinated with military requirements.

Fiscal Realities and Military-Civilian Space Reliance

The future dictates a close relationship between military space requirements and civil space resources, including both operational and research and development realities.[43] Many military space functions closely parallel civil functions. Where these are evident, they should be exploited to save costs to both sectors. Certain functions will continue to be the sole purview of military space. Joint military-civilian space functions include weather, navigation, communications, earth resources, lift, orbit transfer, and tracking and control systems. Integrating many aspects of these systems to serve both military and civil customers could realize massive savings in fiscal requirements to both sectors. Near term examples of probable and possible joint projects follow.

Space weather capabilities should become more economical as DMSP and the National Oceanic and Atmospheric Agency (NOAA) combines soon. The turnover of DMSP responsibilities to NOAA will decrease military investment in weather reconnaissance. Additional savings can be realized by replacing the purchase of next generation military weather satellites with purchasing such data from national sources. Commercial market competition could allow purchase what-you-need only when-you-need-it ability. Care must be taken to ensure on demand military capability.

Space navigation systems can be streamlined as well. GPS could be assigned to the Department of Commerce or Transportation, since demand for such data is well beyond the purview of strictly DOD functions. Alternatively, current GPS systems could be sold to corporations on a cash plus percentage basis, thereby raising cash for additional space resources or developments. Military users could purchase required services as needed. Military priority and

accuracy would need to be protected. Additionally, large constellations such as Intelsat and Iridium could repeat navigation signals for redundant world-wide coverage.

Space communications systems seem to be proliferating rapidly. Microsoft Corporation's Bill Gates plans to exponentially expand such capability with his 840 Teledesic satellite constellation. Teledesic's goal is to bring the information superhighway in all its glory to even the most remote reaches of the globe by the end of the century.[44] Very High Resolution, Hyper-Spectral satellite capabilities are almost a reality. AFSPACECOM sources put expect realization of this within a decade. Commercial enterprises will offer complete, competitive, fast response global coverage, thereby decreasing DOD demands to build and field such systems. Additionally, research for such capabilities is being increasingly funded by the commercial sector due to potential profit.

Lift and orbit transfer may be solved commercially, driven by commercial needs to access space. If such a robust system develops, there would be no need to maintain the military's satellite-booster-operator system. Such a commercial system could make launch-on-demand more realistic due to launch quantity and competitive price forces.

Tracking and control of commercial satellites could be done commercially, with inter-corporation commonality and cost sharing decreasing commercial risk. DOD and NASA could follow corporate footsteps for military satellites, with USSPACECOM controlling all military assets. Alternatively, both corporate and military satellites could be controlled by an integrated national tracking and control system, thereby sharing costs among all users.

The bottom line of this approach to joint military-civil space exploitation is that the huge commercial market would likely dwarf the military needs in space, thereby driving down DOD

space costs.[45] However, the military would need to maintain certain *realistic*[46] standards across the marketplace to ensure its ability to use the systems.

Care must be taken to ensure a capability to closely control these functions in the interest of national security. There are two aspects of this concern. First, the military must have unobstructed and complete access capability in the event of a national emergency, much like the current Civil Reserve Air Fleet concept. For example, contracts with civil communication satellite companies to enable daily dual use, and emergency complete use, of the companies' orbiting resources would be required. Second, the US can increase its security by increasing foreign customer dependence on US-provided systems. For example, the US could provide GPS data on a day-to-day basis at a price that would monopolize the world-wide satellite navigation market, thereby ensuring control of access to or denial of such data in the event of a national emergency.

The space functions that will continue to be the sole purview of the US military include certain surveillance and reconnaissance capabilities, missile warning and defense, most-secure communications capabilities, resource protection, command and control warfare, attack, and space system negation capabilities. Certain near term requirements for a robust space force follow.

Regarding surveillance and reconnaissance, tactical space ELINT/IMINT (TACSATS) for earth observation is needed, unless the National Reconnaissance Office (NRO) can ensure timely and sufficient service. Real-time data fusion of multiple sensor inputs is presently being worked. Accurate geolocation of threats in time and space is needed for prompt preemptive military action.

Space surveillance requirements include providing space traffic control to allow knowledge and control of all space resources, including civil. Resources can be saved by allowing

commercial, university and technical center feeds into a military space traffic control data base to decrease overall collection requirements. Missile warning and defense require surveillance, tip-off, and queuing functions to remain within the military domain for purposes of speed, accuracy and preemptive capabilities.

Regarding most-secure communications capabilities, commercial sources will have corporate secure capabilities. This seems acceptable. In fact, more "routine" military secure transmission requirements could be met more cheaply this way. However, the military must retain most-secure capability for NCA and CINCs' communications, highest priority national security communications, and data links for lethal national assets.

Resource protection remains a military consideration. Hardening of sensors, receivers and transmitters is required to maintain the information edge on future threats (close hold data) and to realize the extent of proliferation of high threats (RF, HPM, Lasers).

Another singular military requirement is large space maneuverability for coverage, evasion, mission responsiveness and flexibility. Such a capability may be on-board a satellite, or may use SST or TAV technology. However, it is not currently relevant to commercial users, so they will not fund such research and development.

Attack and space system negation issues include kinetic energy (KE) and directed energy (DE) force application capabilities, as well as advanced weapons for permanent or temporary, lethal or non-lethal effects. In the age of information warfare, such capability could give the US a selective attack option on enemy or third party information suppliers. Though details about the existence of specific space force application programs are generally classified, a certain amount of information exists in the non-classified media to realize such a capability could be a reality—if not

today, then one day soon. With such a capability, spacepower realizes its maximum political and military flexibility, as discussed earlier.

Space force application capabilities could include kinetic KE as well as DE kill or degradation mechanisms. Such projects as the Tactical Reentry Impacting Munition, Impact Technology Program, Discriminating Attack Capability program, Defense Suppression Vehicle, and Global Prompt Response Capability program all have demonstrated, or discussed, KE kill technologies. The Sandia Winged Energetic Reentry Vehicle Experimental program, and the Hypersonic Glide Vehicle program, both have illustrated high explosives kill technologies. DE kill technologies have been discussed in the Beam Experiments Aboard Rocket program.

The feasibility of all of these technologies, and more, was demonstrated by Phillips Lab's 1991 Force Applications Study. The study concluded such technologies could be used to satisfy USAF operational requirements to:

- Reach out and touch anybody, anywhere, anytime.
- Operate in the fiscal and geostrategic environment of the 1990s and beyond.
- Complement traditional airpower by providing a number of very accurate, very long range, and very responsive weapons.
- Actively support Global Reach-Global Power by lessening reliance on forward deployment and foreign basing, as well as supporting aerospace power objectives of flexibility, range, responsiveness, and lethality.[47]

Due to the ever increasing importance of information technology, other future force application capabilities should include capabilities to exploit, disrupt, or destroy adversaries' information systems. US systems should be able to control adversaries' knowledge-support computer infrastructures to effectively circumvent enemy leadership's decision processes. Such systems should also be able to exploit and affect enemy industrial, electrical, as well as

transportation, infrastructure computer support networks. These types of capabilities would allow the disruption of such systems without the destruction and inherent risks of past strategic air attacks.

Conclusion

Space is not systemically, or inherently, limited. Its physical attributes and application to military characteristics belie no reason for its present relative position vis-à-vis terrestrial forces. It presently exists subordinate to terrestrial powers which, it seems, is for purely "artificial" reasons. Policy seems to be at the root of those reasons. Though a full study of this notion is beyond the scope of this paper, certain things can be done now to enhance spacepower's chances of one day realizing full operational capability across the military mission spectrum.

Space, as a medium to be exploited, is still waiting for a user to get its act together, to determine how and why it can be exploited (a theory) and how to organize, train and equip itself to do so (a doctrine). It must improve on what is already good in its space capability, and fix what is broken. To do this requires a new way of thinking about space and its role in the present, as well as future, world order. Using a comprehensive spacepower theory, the US can organize, train and equip itself better to exploit space. "Better" implies more efficiently, that is faster and cheaper, and effectively, that is via streamlined requirements, and joint military-civil capabilities. The product of this change will be a national ability to defend US worldwide interests at decreased costs in lives, treasure and natural resources.

This work was accomplished in partial fulfillment of the Masters Degree requirements of the School of Advanced Airpower Studies, Air University, Maxwell AFB, AL, 1996.
Advisor: Col Phillip Meilinger, Ph.D.
Reader: Lt Col Robert Owen, Ph.D.

Notes

[1] Modified by President Johnson's remark preceding it, General Mitchell's argument holds as true today for spacepower as it did in his day (this passage was written in 1925) for airpower.

[2] In his well written and informative book *On Space Warfare A Spacepower Doctrine*, (Maxwell AFB, AL: Air University Press, 1988), 7, Lt Col David Lupton, USAF (retired), is more thorough than any other author in dealing with the question of spacepower's usefulness. He articulates four distinct space doctrines, each one based on clearly defined belief structures and historical perspectives. Many of his views are shared by this author and are included in this thesis.

[3] In Peter L. Hays' Fletcher School of Law and Diplomacy doctoral dissertation "Struggling Towards Space Doctrine: US Military Space Plans, Programs and Perspectives During the Cold War," he compares the development of airpower to spacepower in an attempt to determine three critical steps in airpower's development that might explain spacepower's future development.

[4] R.E. Dupuy and T. Dupuy, *The Encyclopedia of Military History,* 2nd rev. ed., HERO Books Partnership, NY, 1986, 934.

[5] Sir Peter Anson and Captain Dennis Cummings (RAF). "The First Space War: The Contributions of Satellites to the Gulf War." *RUSI Journal*, (Winter 1991) Vol. 136, No. 4: 45.

[6] Kennett, *The First Air War.* Title page.

[7] Ibid., 31.

[8] Ibid., 31.

[9] Joint Chiefs of Staff Publication 3-14: Tactics, Techniques and Procedures for Space Operations. (Washington DC: GPO, 15 April 1992), I-15.

[10] Author's personal experience flying F-111Es in Desert Shield and Desert Storm.

[11] Hays, "Struggling Towards Space Doctrine." 27.

[12] Ibid., 59.

[13] Hays. "Struggling Towards Space Doctrine." 27.

[14] Air Force Manual 1-1 (1984), 1–3.

[15] Dana Johnson, in her doctoral dissertation at the University of Southern California, entitled "The Evolution of US Military Space Doctrine," presents an analysis of spacepower's developmental similarities and differences to the USAF and the Navy. She discusses the impact of the varying requirements placed on the space force by all of the services and concludes that space is a truly joint arena, and should be managed to support all services to ensure minimum duplication of effort. She points out that space leaders could learn from a study of airpower and seapower developments.

[16] John M. Collins. *Military Space Forces: The Next Fifty Years.* (Washington: Pergamon-Brassey's, 1989), 6–8.

[17] Ibid., 7.

[18] Ibid., 21–22.

[19] Ibid., 23.

[20] Ibid., 24.

[21] Ibid., 6.

[22] Much of this discussion comes from ideas generated by Carl Builder of the RAND Corporation in notes to Colonel Richard Szafranski, Air War College, National Security Chair.

[23] Ibid.

[24] Phillip Meilinger, Colonel, USAF. "Ten Propositions Regarding Airpower." A paper written in his position as Dean, School of Advanced Airpower Studies, Maxwell AFB, Alabama. August 1994. p. 3.

[25] Department of the Air Force. *Global Presence 1995.* (Washington: GPO, 1995), 13.

[26] Thomas Schelling. *Arms and Influence.* (London: Yale University Press. 1966), 36.

[27] Ibid., Ch. 2.

[28] See *War and Anti-War,* (Boston: Little, Brown and Company, 1993) by Alvin and Heidi Toffler for a thought provoking treatise on the evolution of warfare and technology.

[29] *Global Presence 1995,* 11.

[30] Ibid.

[31] As was the case when Checkmate initially briefed General Horner on the strategic air campaign against Iraq in early August 1990. When the General determined they had no defensive plan, he reacted with dismay.

[32] One might argue the strategic difference between warfighting and peacekeeping, but the infantryman taking fire or the airman reacting to anti-aircraft fires does not recognize this difference.

[33] Edward M. Earle. "Adam Smith, Alexander Hamilton, Freidrich List: The Economic Foundations of Military Power." *Makers of Modern Strategy.* (New Jersey: Princeton University Press. 1986), 217.

[34] This is most evident in the famous "Sunday Briefing" given the first day of all Red Flag deployments. This is a mandatory pre-exercise flight safety briefing and offers statistics showing a relatively higher accident rate. The point of the briefing is not to become a statistic. The USAF Flight Safety School also teaches that accident rates at deployed locations tend to be higher, thereby requiring increased command and safety vigilance.

[35] See Chapter Six for a discussion of lift developments or refer to figure one, this chapter, for associated system developments.

[36] Proof-of-concept of such systems is occurring now. See Durnheim, "DCX Proving Initial Operating Concepts."

[37] IRIDIUM will have a constellation interconnectivity capability.

[38] Interview with the author, Peterson AFB, Colorado, 13 March 1995.

[39] *The War Reports of Marshall, Arnold and King.* (New York: Lippincott, 1947), 455.

[40] Work on lift and delivery vehicles such as Blackhorse, DCX, and other transatmospheric vehicles (TAV) is rapidly progressing. Some estimates put such capabilities, developed primarily by private contractors, only a decade or so away. Transatmospheric vehicles would allow rapid crises reaction (approximately thirty minutes to deliver "influence,", i.e. ordinance, surveillance, supplies, communication, etc. anywhere in the world), flexible targeting (via "atmospheric skipping" the vehicle reenters the atmosphere to reorient its vector in order to deploy anywhere over the planet), long duration presence capability (air refuelablility is a hallmark of TAVs), resupply, rearm, refuel (TAVs will return to earth [or maybe a space station—in the distant future] to refresh), low vulnerability (possibly a zero vulnerability capability given an unmanned vehicle), and relatively high economic value (projected costs for pound into orbit run in the hundreds of dollars, versus thousands of dollars realized by today's inefficient launch means).

[41] Brigadier General William "Billy" Mitchell was court-martialed for his outspoken support of a fully integrated airpower architecture. In the forward of Mitchell's book *Winged Defense,* (New York: GP Putnam, 1925), the publisher writes, "In June 1925, Mitchell was returned to his permanent rank of Colonel and was sent to Texas on account of his outspoken criticism of our military policy in general and our aeronautical policy in particular. William Mitchell has always been a pioneer, and in aeronautics a good deal of a prophet. Prophets, one recalls, aren't always highly regarded at home. At all events, Mitchell, for his outspoken criticisms of things as he sees them in the army and navy, has been pretty well belabored by his official opponents, of whom there are many, however widespread the approval given him and his views by the country at large."

[42] Jacob Kipp, et al. *Soviet Views on Military Operations in Space.* (College Station, TX: Center for Strategic Technology 1986), 223–249. Kipp analyzes Soviet military writings to demonstrate they viewed space as an "independent theater, pursuing independent missions under the direction of a *TVD* headquarters, the direct representative of the *Stavka*, or Supreme High Command. He suggests that "once an independent space theater becomes feasible, space should then become the main *TVD*."

[43] Much of this discussion is gleaned from a presentation the author received from Lt Col Mike Kaufhold, SWC/XR, entitled The Reinvention of Space.

[44] S. Faber. "Global Ambitions," *Discover.* (January 1995), 3.

[45] For a complete discussion of "dual-use," "spin-off," "spin-on," economic-technology interface see such works as *Beyond Spin-Off,* published by Harvard Business School, Anna Slomovic's RAND dissertation on "An Analysis of Military and Commercial Microelectronics: Has DOD's R&D Funding had the Desired Effect?," and Victor Utgoff's chapter in St Martin's Press, *The American Military in the Twenty-First Century.* After a study of such works, the author believes that "dual-use" technologies, or those that can be used by both military and

commercial sectors, but funded by DOD, and "spin-off" technologies, or those that are developed by DOD for DOD use, but which have certain civil application, do not hold as much fiscal promise, and do no reflect the reality of today's commercial technologic revolution, as "spin-on" technologies do. "Spin-on" technologies refer to those which are generally developed and funded by commercial concerns, but which can be adapted for military use. Overall, it is the free market competition that will generate both quality products and affordability applicable to both the military and civil sectors. As Slomovic writes, "If the cost of weapon systems are to be contained, the electronics must be produced by firms which have incentives and opportunities to reduce costs. As this study demonstrates, in the majority of cases the DOD is not getting more advanced components for the higher prices it pays." DOD R&D funds must be spent on special military requirements, i.e. those which have no application in the civil market. However, certain criteria such as reliability, temperature tolerance, and radiation tolerance, once thought to be within the military's unique interest, are now being designed in to civil components. The military must take advantage of these increasing capabilities by applying realistic test criteria and requirements.

[46] In their book *Beyond Spinoff,* the authors note that during the heyday of the spinoff paradigm, i.e. when commercial requirements were being met with defense research and development dollars, "military requirements distorted priorities toward (overly) complex, high performance objectives with limited commercial applicability. . . ." As the spinoff paradigm is left for a more realistic, contemporary, market-place driven, commercial-military interface, the problem should be partially "self correcting," i.e. defense will decline as a fraction of national technical effort. However, care must be taken by the corporations, so comfortable with the spinoff paradigm of the past, to not adopt civilianized versions of "defense technology paradigms." International competitiveness, as well as national economic and military superiority, would suffer. "American business, accustomed to letting DOD carry much of the burden, has been slow in responding to aggressive technological investments by Japanese firms, even as the latter outdistanced them first in process and then in product engineering. The cost to Americans of carrying around the wrong mental image of how the technological system works will be paid in terms of lost markets, overpriced weapons, and wasted resources."

[47] Unclassified final report briefing, *Force Applications Study,* 13 June 1991. (Kirtland AFB, NM: Phillips Laboratory).

BIBLIOGRAPHY

Published Sources

Advanced Technology Warfare. New York: Harmony Books, 1985.

"Air Force Space Doctrine." *Defense Science 2002+* Volume 3 (February 1984): 43–44.

Aldridge, Edward. "Aerial Advantage—Myths About Space Militarization." *Officer* Volume 61 (November 1985): 16–19.

Alic, John, Branscomb, Lewis, Brooks, Harvey, Carter, Ashton, and Epstein, Gerald. *Beyond Spinoff: Military and Commercial Technologies in a Changing World.* Boston: Harvard Business School Press, 1992.

American Council on Education. *Space, America s New Competitive Frontier.* Washington D.C.: Business-Higher Education Forum, 1986.

American Institute of Aeronautics and Astronautics. *Space: A Resource for Earth.* New York, N.Y.: American Institute of Aeronautics and Astronautics, 1977.

Andrews, Walter. "Space-based Defense Called 'Morally Right.'" *Current News* Part I (October 31, 1984): 1–2.

Anson, Sir Peter, and Cummings, Captain Dennis. "First Space War: The Contribution of Satellites to the Gulf War." *RUSI Journal* 136 (Winter 1991): 45–53.

Atwood, Donald. "Preparing to Meet the Future in Space." *Defense Issues* Volume 6 (April 11, 1991): 1-2.

Battelle. "The Strategic Implications of Modifying the Space Environment." *Journal of Defense Research* Volume 15 (Fall–Winter 1983): 135–146.

Baum, Michael E. "Defiling the Altar: The Weaponization of Space." *Airpower Journal* (Spring 1994): 61.

Bell, Trudy and Esch, Karl. "The United States in Space." *Spectrum*, Vol. 28 (August 1991): 18–20, 45–51.

Benko, Marietta. *Space Law in the United Nations.* Boston, MA.: M. Nijhoff Publishers, 1985.

Berkowitz, Marc. "Future U.S. Security Hinges on Dominant Role in Space." *Signal* Volume 46 (May 1992): 71–73.

Berry, Adrian. *The Next Ten Thousand Years: A Vision of Man s Future in the Universe.* New York, N.Y.: Saturday Review Press, 1974.

Blau, Thomas and Goure, Daniel. "Military Uses and Implications of Space." *Society* Volume 21 (January–February 1984): 13–17.

Blechman, Barry. *The American Military in the Twenty-First Century.* St Martin's Press, 1993.

Blow, Thomas. *Defending Against a Space Blockade.* Maxwell AFB, AL.: Air University Press, 1989.

Bono, Phillip and Gatland, Kenneth. *Frontiers of Space.* London: Blandford Press, 1969.

Bousher, Brigadier General Homer A. "Blueprints for Space." *Air Univeristy Quarterly Review* 11 (Spring 1959): 18.

Bova, Ben. *The High Road.* Boston, MA.: Houghton Mifflin, 1981.

Brzezinski, Zbignew, Jastrow, Robert and Kempelman, Max. "Defense in Space Is Not 'Star Wars.'" *New York Times Magazine* (January 27, 1985): 28–29+.

Builder, Carl. *The Icarus Syndrome.* New Brunswick, N.J.: Transaction Publishers, RAND, 1993.

———. *The Masks of War.* New Brunswick, N.J.: Transaction Publishers, RAND, 1992.

Building a Consensus Toward Space. Proceedings of the Air War College 1988 Space Issues Symposium. Maxwell AFB, AL.: Air University Press, 1990.

Burke, William. "Active Space Experiments Affect Treaty Obligations." *Signal* Volume 44 (June 1990): 73–75.

Burrows, William. "Ballistic Missile Defense: The Illusion of Security." *Foreign Affairs* Volume 62 (Spring 1984): 843–856.

———. "Skywalking with Reagan." *Harper s* Volume 286 (January 1984): 50–52+.

Chisholm, Robert. *On Space Warfare: Military Strategy for Space Operations.* Maxwell AFB, AL.: Air University Press, 1984.

Christol, Carl. *The Modern International Law of Outer Space.* New York, N.Y.: Pergamon Press, 1982.

Cole, Dandridge. *The Next Fifty Years in Space: Man and Maturity.* Philadelphia, PA.: General Electric Company, 1963.

Collins, John M. *Military Space Forces: The Next Fifty Years.* Washington: Pergamon-Brassey's, 1989.

Courter, Jim. "Military Space Policy: The Critical Importance of New Launch Technology." *Strategic Review* 22 (Summer 1994): 14–23.

Department of the Air Force. *Gklobal Presence 1995.* Washington: Government Printing Office, 1995.

Dougherty, General Russell, Gabriel, General Charles, Dugan, General Michael, McBride, General William, Marsh, General Robert, and Alison, Major General John. "Facing Up to Space." *Air Force Magazine* (January 1995): 50–54.

Dougherty, William. "Storm From Space." *Proceedings* 118 (August 1992): 48 -52.

Douhet, Giulio. Translated by Dino Ferrari. *The Command of the Air.* Washington, D.C.: Office of Air Force History, 1983.

Durch, William. *National Interests and the Military Use of Space.* Cambridge, MA.: Ballinger, 1984.

Durnheim, Michael A. "DCX Proving Initial Operating Concepts." *Aviation Week and Space Technology* (March 8, 1993): 49.

Dutton, Lyn, ed. *Military Space.* Washington, D.C.: Brassey's, 1990

Earle, Edward M. "Adam Smith, Alexander Hamilton, Freidrich List: The Economic Foundations of Military Power." *Makers of Modern Strategy.* New Jersey: Princeton University Press, 1986.

Faber, Scott. "Global Ambitions." *Discover* (January 1995): 3.

Fradkin, Elvira. *Air Menace: The Answer.* New York: Macmillan Press. 1934.

Friedenstein, Charles. "The Uniqueness of Space Doctrine." *Air University Review* Volume 37 (November–December 1985): 13–23.

Graham, General Daniel. *High Frontier: A New National Strategy.* New York, N.Y.: Tom Doherty Associates. 1983.

———. "High Frontier and Arms Control." *Journal of Defense and Diplomacy* Volume 2 (November 1984): 25–28+.

Gray, Colin. *American Military Space Policy.* Cambridge, MA.: Abt Books. 1982.

Hall, Cargill. "The Origins of US Space Policy." *Colloquy: Security Affairs Support Association* 14 (December 1993): 5–24.

Hartinger, General James. "The Air Force Space Command: An Update." *Air Force Engineering and Services Quarterly* Volume 25 (Summer 1984): 4–9.

———. "Strategic Space Systems Require a Unified Command." *Defense Systems Review*Volume 2 (February 1984): 19–22.

"High Frontier Can Reduce Defense Budget." *High Frontier Newsletter* Volume 3 (January 1985): 1+.

Horner, General Charles. "Space Systems: Pivotal to Modern Warfare." *Defense 94* Number 4 (1994): 20–29.

———. "Unpredictable World Makes US Space Capabilities Critical." *Defense Issues* Volume 9 (1994): 1-7.

———. "Space Seen as Challenge, Military's Final Frontier." *Defense Issues* Volume 8 (1993): 1–10.

Hudson, Richard D. *Infrared Systems Engineering.* New York: John Wiley and Sons, 1969.

"Introduction of Space Weapons Treaty Resolution." *Congressional Record* Volume 131 (April 24, 1985): 1738–1739.

Johnson, Nicholas. *Soviet Military Strategy in Space.* London: Jane's Publishing, 1987.

Kennett, Lee. *The First Air War.* New York: The Free Press, 1991.

Kipp, Jacob, et al. *Soviet Views on Military Operations In Space.* College Station, TX: Center for Strategic Technology, 1986.

Kolcum, Edward H. "Pratt and Whitney Assessing Family of Engines for Upcoming Space Missions." *Aviation Week and Space Technology* (January 6, 1992): 56.

Kingwell, Jeff. "The Militarization of Space." *Space Policy* Volume 6 (May 1990): 107–111.

Kuskuvelis, Ilias. "Satellites for War and Peace." *Proceedings of the Thirty-fourth Coolquium on the Law of Outer Space* (October 1991): 227–232.

Kutyna, General Donald. "SPACECOM: We Lead Today, But What About Tomorrow?" *Defense 91* (July–August 1991): 20–29.

———. "The State of Space." *Defense Issues* Volume 6 (April 23, 1991): 1–8.

Lorenzini, Dino. "Space Power Doctrine." *Air University Review* Volume 33 (July–August 1982): 16–21.

Los Alamos National Laboratory. *United States Space Policy: Review and Assessment.* Los Alamos, NM.: Los Alamos National Laboratory, 1988.

Luongo, Kenneth and Wander, Thomas. *The Search for Security in Space.* Ithaca, N.Y.: Cornell University Press, 1989.

Lupton, David. *On Space Warfare: A Space Power Doctrine.* Maxwell AFB, AL: Air University Press, 1988.

Manno, Jack. *Arming the Heavens: The Hidden Military Agenda for Space, 1945–1995.* New York: Dodd, Mead and Company, 1984.

Marks, Hans. "War and Peace in Space." *Journal of International Affairs* Volume 39 (Summer 1985): 1–21.

McLean, Alasdair. *The Military Utility of Space.* Aberdeen, Scotland: Centre for Defence Studies, 1991.

McDougall, Walter. "Sputnik, the Space Race, and the Cold War." *Bulletin of the Atomic Scientist,* 41 (May 85): 20–25.

———. *The Heavens and the Earth: A Political History of the Space Age.* New York: Basic Books, 1985.

Mitchell, Brigadier General William. *Winged Defense.* New York: GP Putnam, 1925.

Moore, George, Budura, Vic, and Johnson-Freese, Joan. "Joint Space Doctrine: Catapulting into the Future." *Joint Force Quarterly,* Summer 1994: 71–76.

Moorman, Lt General Thomas. "The 'Space' Component of 'Aerospace'." *Comparative Strategies,* Volume 12 (July–September 1993): 251–255.

———. "The Future of USAF Space Operations." *Vital Speeches* Volume 60 (March 1994): 325–329.

Muolo, Michael, editor. *Space Handbook: A Warfighter s Guide to Space, Vol 1.* Maxwell AFB, AL: Air University Press, 1993.

Norton, Oliver. *The Attack and Defense of Little Round Top, Gettysburg, July 2, 1863.* New York: Neale Publishing Company, 1913.

Odom, Lt General William. "Aerospace Requirements for U.S. Security." *Comparative Strategies,* Volume 12: 257–261.

Osman, Tony. *Space History.* New York: St. Martin's, 1983.

Petrie, W. "Military Activity in Space—Is There a Choice?" *Canadian Defence Quarterly* Volume 15 (Winter 1985–1986): 31–36.

Power, John. "Space Control in the Post-Cold War Era." *Airpower Journal* Volume 4 (Winter 1990): 24–33.

Richardson, General Robert. "Technology, Bureaucracy and Defense: The Prospects for the U.S. 'High Frontier' Program." *Journal of Social, Political and Economic Studies* Volume 8 (Fall 1983): 293–299.

Rosenberg, Major General Robert. "The Air Force and Its Military Role in Space. *Air University Review* Volume 37 (November–December 1985): 52–57.

Sadov, Y. "Washington's Space Tricks." *Contemporary Review* Volume 246 (January 1985): 7–8.

Salkeld, Robert. "The Changing Perception of Space: Vehicles, Treaties, Purposes." *Defense Science 2001+* Volume 2 (June 1983): 24–29.

Scoville, Herbert. *Can Space Remain a Peaceful Environment?* Muscatine, IA.: Stanley Foundation, 1978.

Schelling, Thomas. *Arms and Influence.* London: Yale University Press, 1966.

Sgrosso, Gabriella. "Demilitarisation of Outer Space." *Proceedings of the Thirty-fifth Colloquium on the Law of Outer Space* (August–September 1992): 325–334.

Sonneberg, Steven. "The Ultimate High Ground." *Marine Corps Gazette* Volume 74 (May 1990): 58–65.

"Soviet Propaganda About 'Militarization of Space.'" *Defense Daily* Volume 139 (March 4, 1985): 15.

Spaulding, Oliver L. *Ahriman: A Study in Air Bombardment.* Boston, MA.: World Peace Foundation, 1939.

SPACECAST 2020 Final Report, Volume 1. Prepared by the Students and Faculty of Air University. Maxwell AFB, AL: Air University, 1994.

Stares, Paul B. "Space and U.S. National Security." *Journal of Strategic Studies* Volume 6 (December 1983): 31–48.

———. *The Militarization of Space: U.S. Policy, 1945–1984.* Ithaca, N.Y.: Cornell University Press, 1985.

Stine, Harry. *Confrontation in Space.* Englewood Cliffs, N.J.: Prentice-Hall, 1981.

Szafranski, Colonel Richard. *GEO, LEO and the Future.* Maxwell AFB, AL.: CADRE, 1991.

The War Reports of Marshall, Arnold and King. New York: Lippincott, 1947.

Toffler, Alvin and Heidi. *War and Anti-War: Survival at the Dawn of the 21st Century.* Boston, MA.: Little, Brown, and Company, 1993.

Translations of Two Soviet Articles on Law and Order in Outer Space. Santa Monica, CA.: RAND Corporation, 1958.

United Nations General Assembly, Committee on Peaceful Uses of Outer Space. *Report from the Committee on the Peaceful Uses of Outer Space.* New York, N.Y.: United Nations, 1959.

United States Air Force Scientific Advisory Board. *Report on Space Power Technology.* Washington D.C.: U.S. Government Printing Office, 1991.

United States Joint Chiefs of Staff. *Joint Doctrine; Tactics, Techniques and Procedures for Space Operations.* Washington D.C.: U.S. GPO, April 1992.

Vereshchetin, V.S. *Outer Space, Politics and Law.* Moscow: Progress Publishing. 1987.

Verplaetse, Julien. *International Law in Vertical Space: Air, Outer Space, Ether.* South Hackensack, N.J.: F.B. Rothman. 1960.

Wassenbergh, H.A. *Principles of Outer Space Law in Hindsight.* Boston, MA.: M. Hijhoff Publishers. 1991.

Welling, William. "Policy and Strategy Options for the Next Century." *Defense Science 2003+* Volume 4 (June–July 1985): 58–63.

Westwood, James. "Military Strategy and Space Warfare." *Journal of Defense and Diplomacy* Volume 2 (November 1984): 17–21.

Whittington, Mark R. "Stifled By Political Correctness." *Space News* Vol 5 (April 25–May 1, 1994): 15.

Wolf, James. "Toward Operational-Level Doctrine for Space—A Progress Report." *Airpower Journal* Volume 5 (Summer 1991): 28–40.

Worden, Simon and Jackson, Bruce. "Space, Power, and Strategy." *The National Interest* (Fall 1988): 43–52.

Worden, Simon. *SDI and the Alternatives.* Washington D.C.: National Defense University Press, 1991.

Unpublished Sources

Abrahamson, James. "Progress and Policy Paradigms." A paper presented to the 31st *AIAA Aerospace Sciences Meeting and Exhibit*, Reno, NV (January 1993).

Albert, David. "Interdependence in Space?" A paper submitted to the *Journal of Conflict Resolution*, Maxwell AFB, AL (March 1988).

Botte, David. "The United States and National Sovereignty in Outer Space." An Armed Forces Staff College Study, Norfolk, VA, (May 1962).

Carron, Brian E. "The Value of Space Control and How We Can Achieve It." An Air War College paper, Maxwell AFB, AL. (April 1993).

Coursey, Michael. "Evolution of the Space Command from National Space Policy." An Air Command and Staff College paper, Maxwell AFB, AL. (March 1984).

Cox, Dyson. "A Comparison of U.S. and U.S.S.R. Views on Space Law." An Air War College Paper, Maxwell AFB, AL, (January 1963).

Curtis, Edward. "Space Exploration and International Problems in the Use and Control of Outer Space." A San Francisco State College thesis. San Francisco, CA. (1963).

Davenport, Richard. "The Birth of Spacepower: A Doctrine for the 21st Century." An Air War College Paper, Maxwell AFB, AL, (October 1993).

DeSaussure, Hamilton. "The Two Sides of the Law of Outer Space." A paper presented to the *AIAA Colloquium on the Law of Outer Space*, Dresden, Germany, (October 1990).

Dunning, Stephen. "U.S. Military Space Strategy." A Naval War College paper, Newport, R.I. (14 May 1990).

"Force Applications Study Final Report." Unclassified briefing slides from Phillips Laboratory project, 1991.

Ford, James. "Space Force: Organizing for Effective Military Use of Space." An Air Command and Staff College paper, Maxwell AFB, AL. (April 1985).

Hays, Peter. "Struggling Towards Space Doctrine: US Military Space Plans." A Fletcher School of Law and Diplomacy doctoral thesis, 1994.

Hoch, Karl. "Legal Aspects of Military Operations in Outer Space." A paper presented to the *Air University Airpower Symposium*, Maxwell AFB, AL (1981).

Howard, William and Rosenberg, Robert. "Future Military Space Systems and the Principles of War." Dahlgren, VA.: Naval Space Command, 1990.

Howarth, Thomas. "The Impact of Space on Future Wars (or: Will World War III Be Waged in Space?)." A Naval War College student thesis, Newport, R.I. (February, 1989).

Johnson, Dana. "The Evolution of U.S. Military Space Doctrine: Precedents, Prospects and Challenges." A University of Southern California doctoral thesis, 1987.

Lentini, Joseph. "Will Congress Support a Space Control Policy?" An Air Command and Staff College paper, Maxwell AFB, AL. (April 1984).

Lorenzini, Dino. "2001: A U.S. Space Force." A paper presented to the *Air University Airpower Symposium*, Maxwell AFB, AL (1981).

Lyall, Francis. "Space Law—What Law or Which Law?" A paper presented to the *AIAA Colloquium on the Law of Outer Space*, Dresden, Germany (October 1991).

McFarland, R.S. "The Impact of Space Systems on Future Warfare—A Warrior's Perspective." A Naval War College paper, Newport, R.I. (1980).

Meilinger, Colonel Phillip. "Ten Propositions Regarding Airpower." A paper written in his position as Dean, School of Advanced Airpower Studies, Maxwell AFB, AL. (August 1994): 3.

Piotrowski, John, General, USAF. "Space Warfare and the Principles of War." Colorado Springs, CO.: United States Space Command, 1989.

Smith, William. "Potential Legitimate Use of Space Weapons as Part of the United States' Strategic Forces." An Air Command and Staff College paper, Maxwell AFB, AL. (May 1980).

Sponable, Jess. "Single Stage Rocket Technology Program Reveiw of Future Systems and Applications." Unclassified briefing viewgraphs, Ballistic Missile Defense Organization, January 1993.

Weston, Craig. "The Essence of Spacepower: Important Influences on the Evolution of National Spacepower." An Air War College Paper, Maxwell AFB, AL, (May 1989).

Interviews

Colonel John S. Boone, United States Space Command (USSPACECOM)/J-5V, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Colonel Larry L. Byrd, USSPACECOM/J-33V, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Colonel Robert K. Chadburne, USSPACECOM/J-5X, numerous telephone discussions with author, January–March 1995.

Colonel Gary W. Dahlen, USSPACECOM/J-3V, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Major General Roger G. DeKok, Air Force Space Command (AFSPACECOM)/XO, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Colonel Marc J. Dinerstein, USSPACECOM/J-33O, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Major Bill Doyle, USSPACECOM/J-5X, numerous telephone conversations with author, October 1994–May 1995.

Colonel Gregory L. Gilles, USSPACECOM/J-5I, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Lt Colonel Mike Kaufhold, Space Warfare Center/XR, numerous telephone interviews with author, February–March 1995, and personally interviewed by author during visit to Falcon AFB, Colorado, 11–18 March 1995.

Lt General Jay W. Kelley, Air University Commander, numerous discussions with author, September 1994–March 1995, and personally interviewed by author at Maxwell AFB, Alabama, 3 March 1995.

Colonel Kenneth D. Riley, USSPACECOM/J-33, interviewed by author during visit to Peterson AFB, Colorado, 11–18 March 1995.

Colonel Richard Szafranski, Air War College/Chairperson, National Security Studies, numerous discussions with author, September 1994–June 1995.

Major General David L.Vesely, Space Warfare Center Commander, interviewed by author during visit to Falcon AFB, Colorado, 11–18 March 1995.

Lt Colonel Mike Wolfert, AFSPACECOM/XPX, numerous telephone interviews with author, February–March 1995.